Materials & Methods

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MATERIALS

ENGINEERING

September

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IN the nation's display windows and on assembly lines for producers' goods the phenolic plastics . . . and these are the Durez plastics . . . are showing their wonderful versatility. Even among the "general purpose" compounds, Durez continually provides buy-appeal and desired performance factors in new shapes, as shown here. These are the compounds your molder probably knows best, and can shape to your ends with impressive time and labor savings.

If you're in a hurry to get things moving, you'll find practical advantages in our continuing plant expansion program, perfected quality controls, and new laboratory facilities. As specialists in phenolics, we can advise you on material and finishing economies inherent in these plastics, and the use of mass production methods. Let us send you "Durez Plastics News," showing each month what other manufacturers are accomplishing with Durez.

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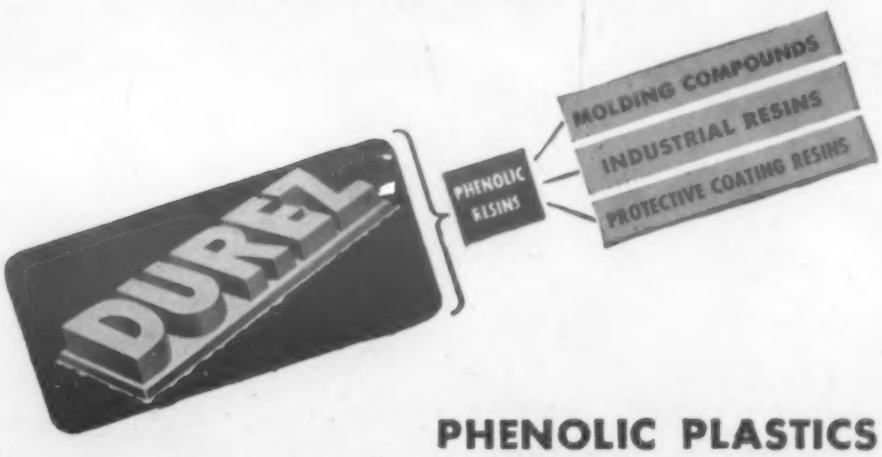
Export Agents: Omni Products Corp., 460 Fourth Avenue, New York 16, N. Y.

"BUY-APPEAL" IS TAKING many new shapes

CONSUMER GOODS using Durez widely include this 5½ lb. A. C.-D C. Sentinel "Treasure Chest" radio. Eight molded pieces comprise the housing and novel controls. Colors of ribbed cabinet harmonize with other Durez parts. Front cover has inner and outer shells with loop aerial between. Molded-in holes avoid the need for machining.

THE ELECTRIC MIXER gains much eye-appeal from its Durez one-piece motor housing and handle. This plastic is non-corrosive, easy to keep clean, sanitary. Its shape suggests the care with which intricate forms are obtained with Durez. **Courtesy, Whippit Appliances, Inc.**

BRAND NEW APPROACH to a willing market is the Moldmaster line of personal correspondence, card and stationary files for executives. Molded Durez handle and sides with embossed panelling produce a warm, modern treatment that gives new salability to old stand-bys. Produced and sold by Art Steel Sales Corporation.



PHENOLIC PLASTICS that fit the job

Materials & Methods®

VOLUME 28, NUMBER 3 • SEPTEMBER, 1948

PLASTICS EXPOSITION ISSUE

FEATURE ARTICLES

MATERIALS & METHODS MANUAL NO. 41

ENGINEERING FILE FACTS

DEPARTMENTS

NEXT MONTH METAL SHOW ISSUE: Metal Show Preview . . . How the U. S. Stands in Mineral Resources . . . Design of Copper-Base Alloy Hot Die Pressings . . . Steel vs. Aluminum for Automotive Products . . . Control of Surface Finish . . . Heat Treating Creep Resistant Alloys . . . Materials for Collapsible Tubes . . . Precision Investment Castings Reduce Assembly Operations . . . FREE-CUTTING STEELS (Materials & Methods Manual No. 42)

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RYERSON STEEL

The MATERIALS OUTLOOK...

Continuous casting of semifinished steel is seen as one answer to decentralization of steel industry. . . . Republic Steel and Babcock & Wilcox worked experimentally for several years. . . .

First shipment of bars for continuously cast billets made in March this year. . . . Long enough for finished steel to be tested in service. . . . New process is cutgrowth of practice commonplace in nonferrous fields. . . . Brass molds have definite structural and fabricational advantages for this process. . . .

From the user's standpoint, continuous cast steel means finer grain steel with less segregation and fewer inclusions. . . . Forms now produced include rounds and flats.

Tin shortages will continue to plague industry. . . . Government purchasing of tin for stockpiling is being urged regardless of effect on industrial users. . . . Government officials cite non-essential uses of tin as evidence that industry does not absolutely need all it is getting. . . .

Nylon coating is adding considerably to the life of wire rope. . . . Particularly the grades of rope used on hoisting equipment. . . . Plastic sheathing protects wire from rolling and twisting action of pulleys and drums. . . . Also reduces corrosion losses.

Black aluminized strip steel (described in August M & M) has many electronic uses. . . . Other uses in nonrelated field should follow in applications where heat emission is important. . . . Replacing bright surfaces which conduct but do not dispel heat accumulations. . . . Laboratory experts think bright colors would never be used for radiators if designers understood physical principles of radiation.

Aluminum supply situation, already tight, made worse by Pacific Northwest floods. . . . How severely is now known. . . . U. S. primary aluminum output dropped 13,334,823 lb. in June over May. . . . Even plants not flooded lost production through curtailment of power. . . . Outlook still dark. . . .

Little prospect of improved aluminum supply even with increased imports of high-grade bauxite. . . . Power deficit for producing this metal likely to reach 1,000,000 hp. by 1952 unless new sources of power are added quickly. . . . Country's plant capacity could add 175 million pounds of aluminum annually — still not enough to meet demand — if power supplies should suddenly become available.

Titanium, world's fourth most abundant metallic element, attracts the attention of more materials engineers every day. . . . Remington Arms (du Pont affiliate) announces extensive research program on fabrication and alloying of titanium. . . . Remington as well as Bureau of Mines offers sample quantities for field evaluation as an engineering material. . . . Suggested uses now are aircraft parts (replacing magnesium), diaphragms, textile machinery, automotive pistons. . . . Titanium, unalloyed, is claimed to be four times as strong as magnesium; twice as heavy. . . . Another comparison: titanium weighs about 40% less

(Continued on page 4)

The Materials Outlook *(Continued)*

than a given section of stainless steel. . . . Has added advantage of corrosion resistance to atmospheres and sea water.

Urea crystal, in short supply since war's end, now more readily available. . . . Result is greater quantities of urea-formaldehyde molding materials and resins. . . . American Cyanamid Co. has completed Wallingford, Conn., expansion which doubles prewar capacity for molding materials and resin adhesives. . . . Latter material important to plywood plants hampered by shortages in producing high-grade, resin-bonded plywood.

Desperate demand for metals reflected in increasing scarcity of stainless steel. . . . Orders for stainless, plentiful since war, not being booked for last quarter of 1948 by some large producers. . . . Industry produced 180,000 ingot tons nine years ago as compared to 520,000 tons in 1947. . . . This year's output should top that figure.

Jewelry manufacturers now looking with extreme favor on palladium. . . . Easily cast, it can be used in intricate shapes. . . . Other plus values: Easy on tools and dies; doesn't chip stones and holds them securely; takes high polish; retains brilliant whiteness.

A new copper-base alloy with small additions of cadmium and zirconium is becoming available for seam welding electrodes and similar applications. . . . P. R. Mallory, developer, claims high electrical conductivity (75 to 80% of standard copper); high thermal conductivity; good strength (tensile, 72,000 psi.). . . . Best properties develop after heat treatment and cold working.

Westinghouse now produces thorium, a fissionable product in a class with uranium, to a purity of 99.5% plus. . . . Basis of new patented process is control made possible by carrying work on under glass. . . . . Previously a thorium oxide-calcium mixture was heated in a massive iron bomb.

A British inventor has perfected a method for producing selenium in fibrous form similar to glass wool. . . . Molten selenium is sprayed through a series of nozzles into a chamber where it forms a felted mat of "wool" on a moving belt. . . . Mats are cut into disks for rectifier and photocell use.

Tightness of pig iron supply highlighted by two recent events. . . . Blast furnace of Mystic Iron Works, near Boston, burned out and not to resume operations until November, hits most New England foundries. . . . Cleveland area foundries fearful of results of sale of WAA blast furnace there operated until now by Republic Steel. . . . Failure of Mystic furnace may be forerunner of more furnaces going down, since most have been operated at accelerated rates since war's end.

A new thermosetting plastic resin, about to be announced, has remarkably short curing time. . . . Reported as curing in about 25 sec. . . . Plastic also has high heat resistance, low moisture absorption, unusual electrical characteristics, exceptional dimension stability.

Predictions are that capacity for wrought magnesium products -- extruded, deep drawn, rolled, forged -- will be expanded by 50 times in the next five years. . . . Any intensive armament program will spur expansion. . . . Armed forces going to magnesium for portability, among other things.

AN EDITORIAL

Hats Off to Plastics

On one score or another plastics as engineering materials have taken a large panning since the inception of their industrial careers a few years ago. They've been called by their critics weak, expensive, oversold, misrepresented, glamorized, a fad, and other words which the postal laws forbid us to use in printed matter sent through the mails.

Much of this was at one time justified, and some of it still applies to certain plastics (remember there are scores of different plastic materials, not just one). But an open-minded reading of Sherman's lead-off article and Mack's manual in this issue clearly shows the extent to which these modern materials have matured, both economically and technically.

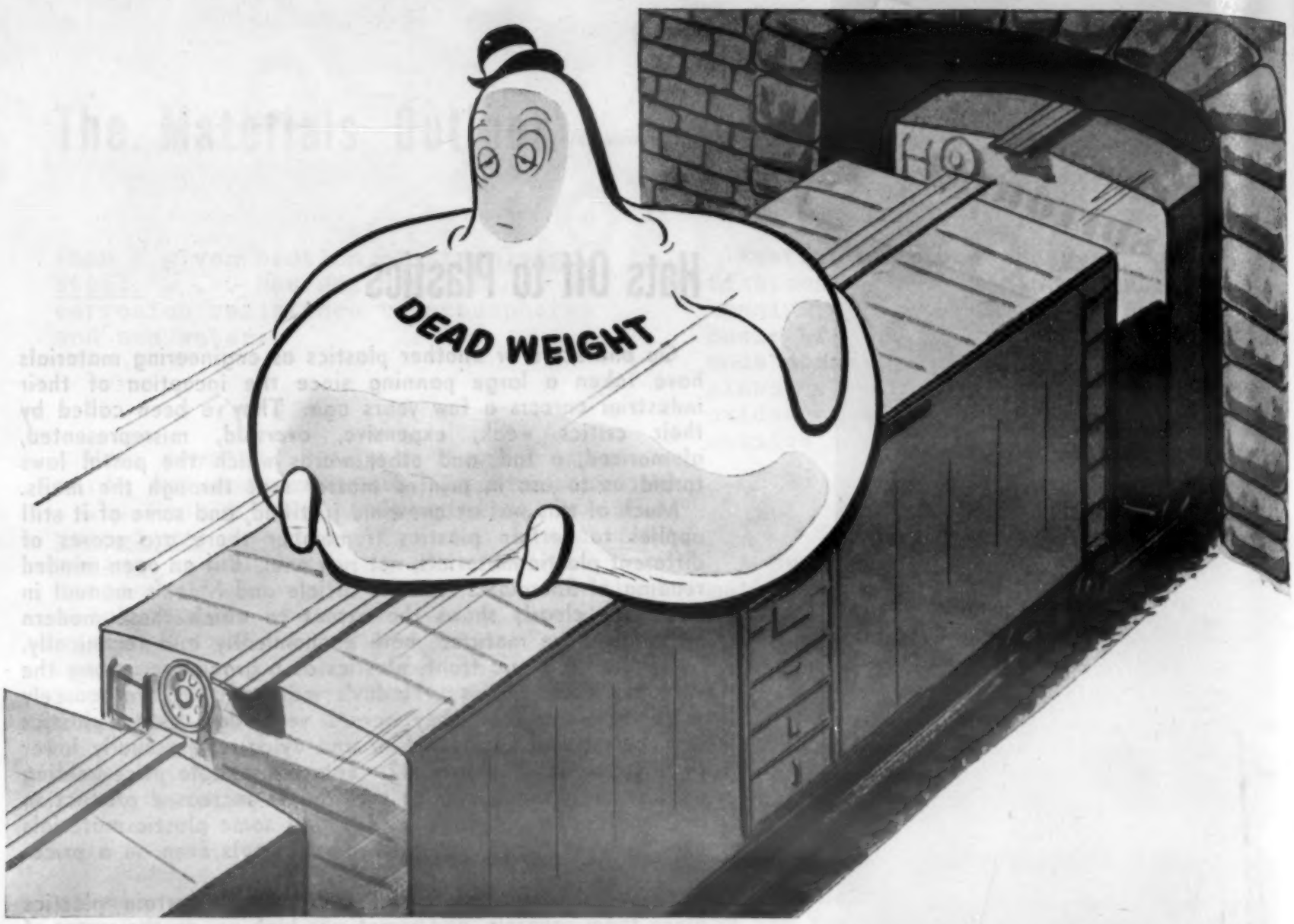
On the economic front, plastics as a group are among the very few commodities in today's markets that are scarcely more expensive than they were 5 years ago. *Some* plastics (*e.g.* polystyrene, polyethylene and nylon) are actually lower in price today than in 1942. This remarkable price-holding achievement, which can be credited to increased production and improved technology, means that some plastic materials are now cost-competitive with most metals even on a price-per-pound basis.

The engineering properties available in certain plastics place them squarely, and sometimes high up, on the roster of useful engineering materials. Bearings, gears, cams, refrigerator linings, ducts, hot-plate covers, pontoons and printing plates are among the newer successful uses that demonstrate the selective durability of engineering plastics, while certain of the laminated plastics can boast of the highest strength/weight ratios of all the common lightweight structural materials.

Industrially, the "plastics industry" is now doing a wise and workmanlike job in disseminating sound technical information about its products, and especially in promoting careful testing of proposed applications before placing them on the market. "Overselling" is considered a heresy, and all factors in the industry are staying away from it in droves. Even the still-young Plastics Show, with its judicious 18-month interval "between drinks," could stand as an imitable model, in this respect, for some of its older counterparts.

Yes, engineers who still think of plastics as essentially high cost materials, unable to sustain loads over a few thousand psi. or temperatures above 200 F, and incapable of fabrication into large structures and "difficult" shapes, are ignoring some of the best opportunities to build better products through the intelligent use of industry's most-improved group of materials. And that is foolish, gentlemen, for—like the automobile and the airplane—these plastics are here to stay!

FRED P. PETERS



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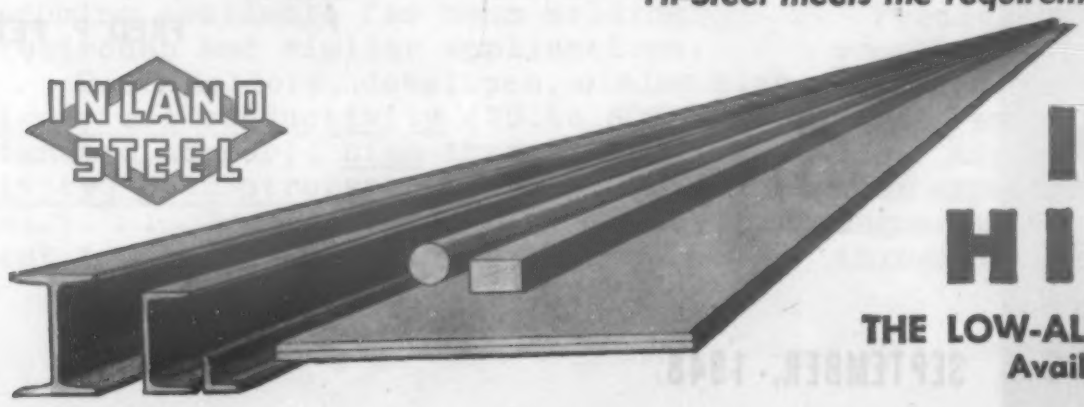

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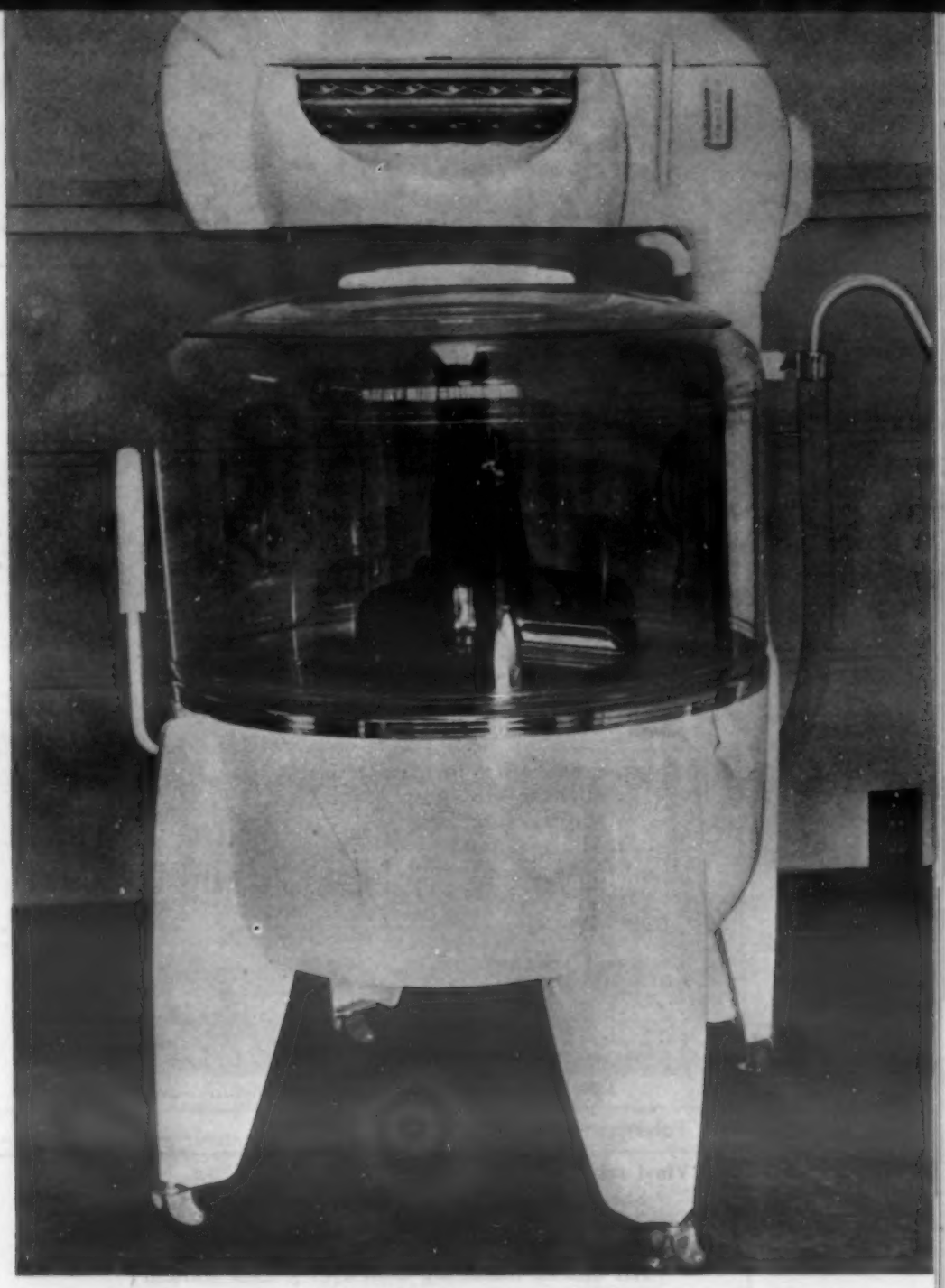


Acrylic plastics are used by Regal Plastics Co. to produce demonstration models of washing machines. This washer tub was molded in three pieces.

Better Supply and Price Situation Forecasts Increased Use of Plastics

by **JOSEPH V. SHERMAN**

INCREASING SUPPLIES OF PLASTICS at prices that have risen much less than those of other materials indicate a greatly strengthened competitive position for plastics as a group. These factors foreshadow increasing competition not only between plastics and other materials but also among the different plastics materials themselves. With the elimination of shortages, the plastics industry is entering into a buyer's market, and it is therefore appropriate for every user or prospective user of these materials to reappraise his particular applications in the light of the changed over-all situation.

Table I—Consumption of Plastics in 1947 Compared with 1946

	1947	1946
	(Thousands of Lb.)	
Cellulose acetate and mixed ester:		
Continuous sheeting, under 0.003 gage	7,227	7,650
Continuous sheeting, 0.003 gage and upward	7,844	7,500
All other sheets, rods, and tubes	3,851	4,715
Molding and extrusion materials	58,524	83,204
Total	77,446	103,069
Nitrocellulose plastics:		
Sheets	9,217	10,932
Rods and tubes	3,669	7,229
Total	12,886	18,161
Other cellulose plastics	N.R.	12,183
Phenolic and other tar acid resins:		
Laminating (dry basis)	40,546	27,725
Adhesives (dry basis)	21,069	16,121
Molding materials	193,969	139,624
All others, including casting (dry basis)	63,456	58,201
Total	319,040	241,671
Urea and melamine resins:		
Adhesives (dry basis)	48,554	40,797
Textile and paper treating (dry basis)	15,949	13,534
All others, including laminating (dry basis)	9,789	N.R.
Total	74,292	
Polystyrene	94,991	66,769
Vinyl resins:		
Sheeting and film, including safety glass	66,426	52,079
Textile and paper coating resins (resin content)	17,236	11,673
Molding and extrusion materials (resin content)	73,114	61,852
All others, including adhesives (resin content)	27,062	27,083
Total	183,838	152,687
Miscellaneous resins:		
Molding materials	56,404	N.R.
All others (dry basis)	29,574	35,690

N.R.: Not Reported
Source: Bureau of the Census, U. S. Department of Commerce

Plastics are today going into such a wide variety of products—surface coatings and adhesives, as well as all kinds of molded and fabricated articles and parts—that it is difficult to say just where the largest increases in consumption have taken place. It is known that increasing quantities of plastics are going into the textile industry, for example, vinyl coatings for rainwear. Also, wall tile and floor tile are taking growing amounts of plastics. It is estimated that linoleum floor coverings now take around 10 million lb. of vinyl materials annually. At the same time that plastics have been finding such new uses, they have also been expanding their fields of applications in established markets. For example, there has been a staggering increase in the use of plastics in toys and novelties since the prewar years.

Production of plastics and synthetic resins rose to an all-time high of around 850 million lb. in 1947. This compared with 728 million lb. in 1946 and 247 million lb. in prewar 1939. The 1947 total represented a gain of 16% over 1946 and was more than triple the 1939 figure. Surveys show that sales of compression and injection molded items in 1947 amounted to $130 million, a gain of some $7 million over 1946.

The totals, however, tend to obscure the fact that many plastics have shown much greater increases than the group as a whole, while some have actually declined. Thus, the phenolics, which are still the most important type, the urea and melamine resins, the vinyl resins and polystyrene, all showed substantial increases in 1947 over 1946. Only the cellulose plastics had declines during the year. See Table I.

Of the two principal divisions of plastics—the thermosetting (heat resistant) and thermoplastic (heat softening), it is interesting that most of the shifts in the use of plastics have occurred in the latter group, which includes most of the new ma-

terials that have been introduced in recent years. Particularly noteworthy has been the displacement of cellulose acetate by polystyrene.

Cellulose acetate molding powder showed rapid growth from 1934 when injection molding came in until 1946 when it reached a peak output of 83 million lb. It was one of the most widely used plastics in the automobile industry as well as in a broad range of consumer goods. Then in 1947, cellulose acetate molding powder got its first setback when consumption fell to 58 million lb. The decline of 25 million lb. in cellulose acetate molding powder was offset by a gain of 28 million lb. in polystyrene which reached a new peak of 95 million lb.

Trend Toward Polystyrene

The figures not only tell the story of what has happened but, in the opinion of well-informed sources in the industry, mark a permanent trend away from cellulose acetate toward polystyrene. Polystyrene is considerably cheaper than cellulose acetate and it has a number of important advantages such as lower moisture absorption and better stability, as well as better electrical characteristics. On the other hand, cellulose acetate has a distinct advantage in toughness, which has dictated its use in many applications, notwithstanding its higher price. However, considerable research is now under way to overcome the brittleness of polystyrene, and success here would put it on a new competitive footing.

The displacement of cellulose acetate by polystyrene is somewhat reminiscent of the earlier displacement of nitrocellulose (celluloid) by the acetate, which is nonflammable.

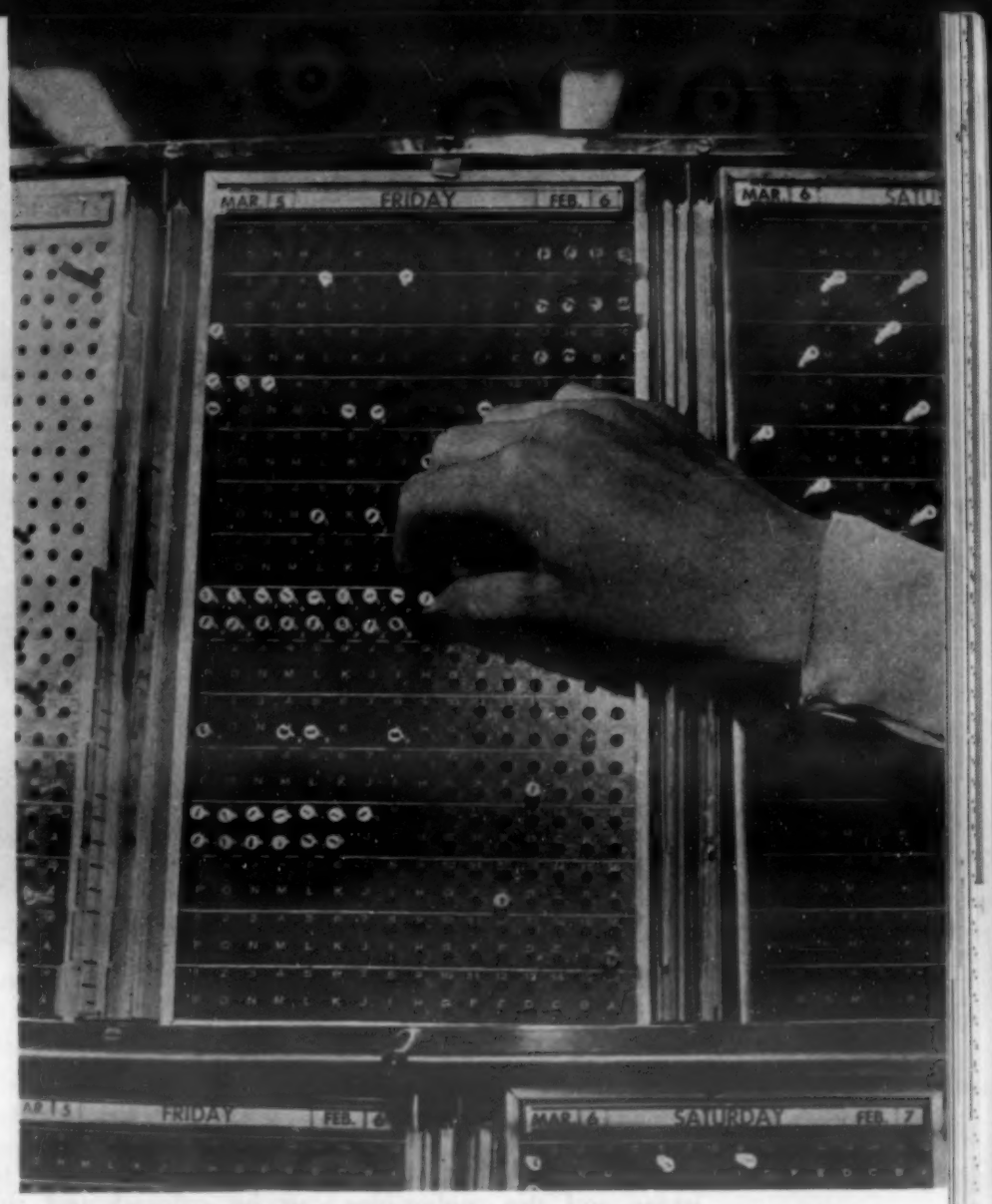
Polystyrene has also replaced some cast phenolic resins in such applications as brush backs due to greater speed of production possible.

Another group of thermoplastics which have had rapid growth are the vinyl resins. The vinyls can be plasticized and given elastomeric properties like rubber. The big increase has been in elastomeric vinyls rather than in rigid vinyls, and this trend is expected to continue. The vinyls are among the most versatile of plastics and are widely used as molding and extrusion materials, sheeting and film, textile and paper coating resins, and adhesives. All uses except adhesives showed big gains last year.

It is believed that plasticized vinyls will get more and more business that is now going to rubber. One of rubber's drawbacks is that it becomes brittle due to oxidation, or sticky and soft due to depolymerization. Not only are the vinyls definitely superior in these respects but they can be extruded and given bright colors. One of the large vinyl producers visualizes colored vinyl pedal pads for automobiles instead of the colorless rubber ones now used. The whole question of competition is largely one of price, and as the price differential between the vinyls and rubber is narrowed, they will undoubtedly be used in more and more places because of their superior properties.

The phonograph record industry is also using increasing quantities of vinyl resins because records made of them are nonbreakable and have superior tone qualities. With light pick-ups, the vinyl records last longer before they deteriorate in quality. Also, the records can be made in color.

A promising new use of the vinyls is in paints, such as antifouling paint for ships.



Vari-colored plastic pegs are used in a new system of train reservations recently inaugurated. (Photo: Courtesy Celanese Corp. of America)

Polyethylene Uses Outstrip Production

Polyethylene, one of the new plastics developed since the war, has experienced such rapid increase in demand that supply has not been able to keep up with it. A wide variety of articles made of polyethylene, such as flexible tumblers, refrigerator trays, cigarette cases, coasters, and cosmetic containers have appeared on the market and some of them have since disappeared due to shortages of material. However, the supply situation for polyethylene is expected to improve later this year as the two large producers are expanding their productive capacity.

When we turn our attention to the thermosetting plastics, we find that there have been few shifts from one material to another comparable to those which have taken place in the thermoplastics. The phenolics, oldest of the thermosetting resins, still accounted in 1947 for around 80% of the total output of all the heat-resistant plastics. Also, the phenolics are still the cheapest of all plastics materials.

The urea and melamine resins, both of which are newer than the phenolics, have made rapid advances in use in recent years, but these have represented new

Many plastic materials are being used in upholstery applications, such as these pieces covered with Lumite fabrics.

applications rather than competitive ones. Both the ureas and the melamines can be colored and they therefore have more consumer appeal than the phenolics but they are also more expensive.

Principal uses of the urea resins today are in buttons, closures, electrical wiring devices, and housings for radios and the like. Biggest markets for the melamines are in tableware and buttons. In general, the newer melamines supplement rather than compete with the urea resins. One example of this is that the ureas were used for picnic ware but the melamines opened up the whole field of restaurant and heavy-duty tableware. It is reported that one large chain of restaurants has adopted melamine tableware because of the great saving resulting from elimination of breakage formerly experienced with chinaware. Other new uses are awaiting larger plastics supplies.

Outlook for Plastics Supplies and Prices

Supplies of plastics, in general, have shown definite improvement over the past year. To a large extent this has resulted from increased production as new facilities have come into operation, but in certain cases it has been due to decreased demand, particularly for some types of luxury and semi-luxury goods which utilize plastics. On the whole, supply and demand have been brought into better balance in the plastics industry than at any other time since the war, and the industry is gradually emerging from a seller's into a buyer's market. However, each plastics material must be considered separately, since each is produced by different companies and is subject to different market factors.

Output of thermosetting molding materials has continued at levels above 1947 as expanded facilities of producers have come into operation. Productive capacity is believed to be adequate and output sufficient to meet virtually all requirements. It is expected that production will be somewhat increased this year. Based on current plastics requirements, there is at present no prospect of shortages in thermosetting molding materials.

Phenolics—The bottleneck here has been in phenol, as the supply situation with respect to formaldehyde has definitely improved. One large producer of phenolic plastics expressed the opinion that the strike at the Dow Chemical Co., Midland, Mich., plant might have an adverse effect on the situation as Dow is one of the largest producers of synthetic phenol. Also, a strike has recently ended at the Durez Plastics & Chemicals plant, a large producer of both phenol and phenolic plastics. The spokesman quoted said that he had hoped that production of phenolic plastics for the year 1948 would exceed 1947 but that this expectation is predicated on freedom from further strikes. However, a spokesman for another large producer of phenolic plastics said that they were not too concerned regarding the strikes in certain plants in view of the over-all improvement in the supply situation.

Most producers report that supplies of phenolic materials are in a relatively good position at this time and that they are able to take care of most requirements. Moreover, inventories are said to be very good.

Urea and Melamine Resins—Supplies of urea and melamine resins are reported to have shown definite improvement within recent months. New facilities for the production of urea and melamine materials have been added which will double capacity. One of the largest producers of these resins said that beginning in August there should be a substantially increased supply and that no critical shortages of urea and melamine resins are expected after the fall of this year. Previously, these materials were on an allocational basis.

Polystyrene—Polystyrene is now in free supply and substantial new productive capacity is coming into operation. It is estimated that polystyrene capacity should reach 200 million lb. by the end of this year. However, conservative members of the industry do not expect consumption in 1948 to be more than 25% over 1947, or approximately 115 million lb.

Vinyl Resins—Productive capacity for vinyl resins will be considerably greater this year than last and consumption is expected to exceed 200 million lb., compared with 184 million lb. in 1947. Some members of the industry estimate that vinyl resin consumption in 1948 will approximate 235 million lb. and some expect it to go even higher.

Cellulose Plastics—Both cellulose acetate and cellulose nitrate have been in good supply. Ample supplies of cellulose nitrate should be available this year. Productive capacity for cellulose acetate was increased in 1947, and supplies should be sufficient to meet demand in 1948. Ethyl cellulose was in good supply last year and present capacity should meet requirements this year.

Miscellaneous Plastics—Supplies of methyl methacrylate, nylon and other miscellaneous thermoplastics are reported to be much easier all around and no shortages are foreseen. To a large extent these plastics have been going into items of a luxury and semi-luxury nature for which demand has recently fallen off from previous levels.

The plastics industry has been taking advantage of the seasonal lull in demand to increase stockpiles of materials in anticipation of the pick-up in business later in the year. It is not going to be caught short again if it can help it. Asked whether the industry will be able to sell all the increased output made possible by expanded productive capacity, one spokesman replied that it would take a lot of development work in promoting new uses for plastics.

Prices

Up until recently there had been a definite downward trend in prices of plastics. Prices of several plastics, such as polystyrene and polyethylene, were being reduced even during and after the war when prices of most commodities were going up sharply. Within recent months, however, the inflationary rise in costs of producing all commodities has more than offset economies in the cost of producing plastics, and the downward trend has been reversed. Nevertheless, the advances in prices of plastics have been much more moderate than in those of competing materials, and on a relative basis, plastics are today cheaper than ever before.

Such advances as have been made in plastics prices have been relatively small. General-purpose phenolic molding powder which, before the war, sold at 13½¢ a lb., now sells at 16½¢, the last increase having been put into effect in Nov. 1947. Slight increases were recently put into effect for urea and melamine resins. In Mar. 1948, the price of urea resin in large quantities was raised from 27½¢ a lb. to 28¢. The increase was greater for smaller quantities. In June 1948, the price of melamine resin was raised slightly for small quantities but no increase was put into effect for large quantities.

Table II—Typical Prices of Molding Materials

	Price Range Per Lb.
Thermosetting	
Phenolic	$0.16½-0.28
Urea	0.28-0.45
Melamine	0.40-0.55
Thermoplastic	
Polystyrene	0.27-0.42
Vinyl	0.36-0.50
Cellulose acetate	0.42-0.54
Polyethylene	0.46-0.56
Acrylic	0.65-0.80
Nylon	1.60-4.50

Price of polystyrene, which had been cut nearly in half since 1942, was increased slightly in Jan. 1948. The rise per lb. was 2¢ for the crystal, bringing it to 27¢, and 1¢ for the colored, bringing it to 33¢.

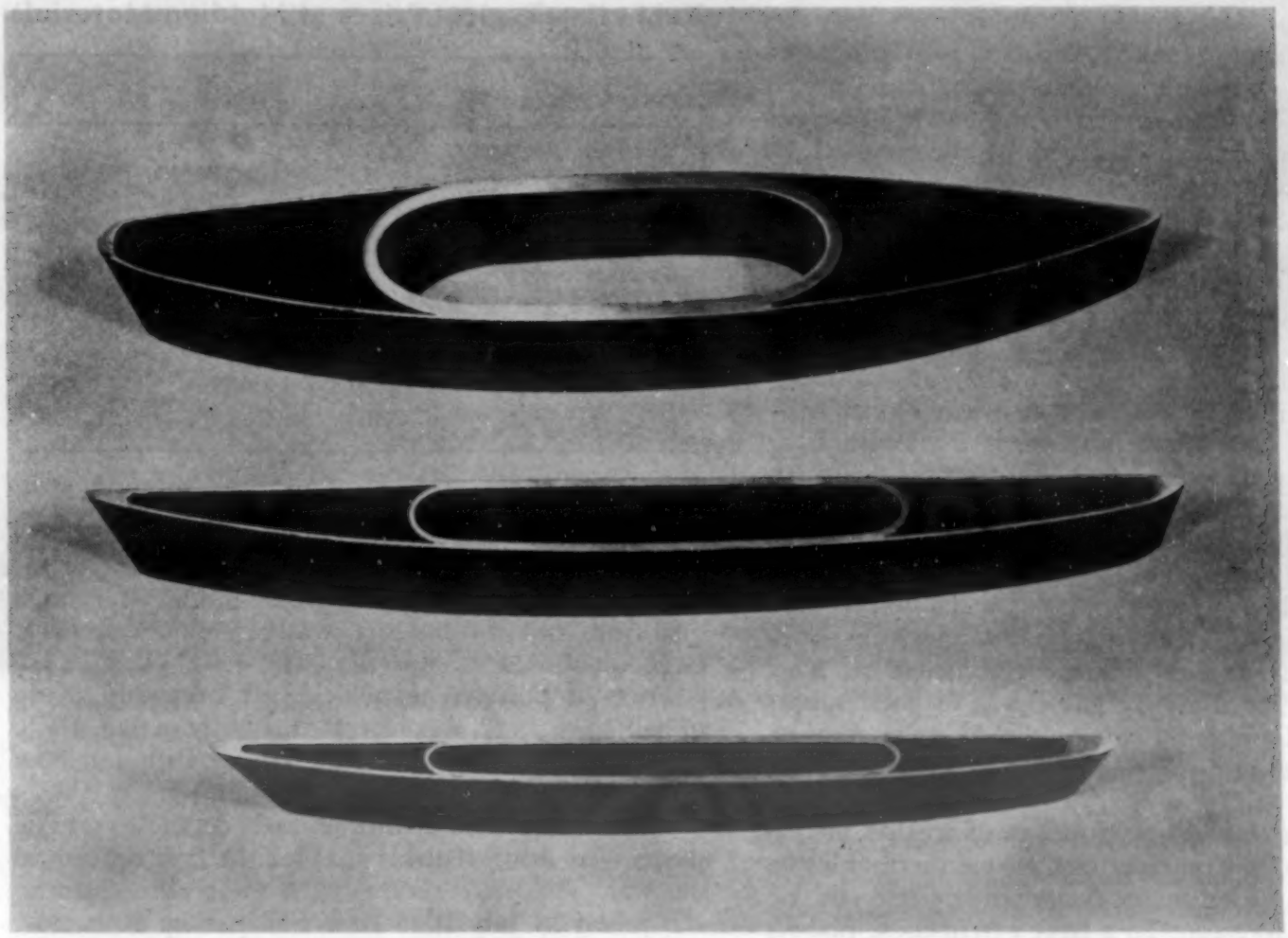
Prices of cellulose nitrate and cellulose acetate sheets were advanced this year for the first time since the war. The price of methyl methacrylate sheeting was raised in July 1948 from 75¢ per sq. ft. to 80¢.

Some plastics prices are still pointing downward. Polyethylene was again reduced in Nov. 1947. to 46¢ a lb. for the uncolored and 52¢ for the colored. Nylon molding powder was reduced in May 1948 from $2.50 a lb. to $2.25. One manufacturer has lowered prices approximately 25% on vinylidene chloride film in widths up to 40 in., as a result of expanded production facilities.

Future Price Trends

The plastics industry has had an outstanding record in reducing prices over a period of years. This has resulted from operating economies of large-scale production, as well as utilization of cheaper sources of raw materials and more efficient processes. If it were not for the forces now at work in the national economy making for higher costs all around, it would be reasonable to expect a continuation of the downward trend in plastics prices long under way. However, the plastics industry, like all other industries, has to pay higher wages to its labor and higher prices for its raw materials, and such general factors are pushing up the level of costs in the industry. The future trend of plastics prices, therefore, will be determined largely by economic forces in general rather than by factors within the industry itself.

It is reasonable to expect, however, that the differential between plastics prices and prices of competing materials will be further narrowed because of the almost unlimited sources of raw materials for plastics, as contrasted with certain other materials such as wood and metals which are becoming scarcer and more expensive, and the vast amount of research under way in the industry to find cheaper materials and more economical methods of production.



These three cross-sections at different points between base and tip show the changing contour of the blade. The dark areas between spar and shell is filled with rubber.

Steel and Rubber for Aircraft Propellers

by KENNETH ROSE, Engineering Editor, MATERIALS & METHODS

THE PROBLEM OF WEIGHT is exceedingly important in aircraft design, and the reduction of weight without undue sacrifice of strength is a principal function of materials engineers in the aircraft industry. Every part of the plane and its accessories is subjected to rigorous scrutiny and to constant review with the idea of the possibility of weight saving in mind.

Early aircraft propellers were made of wood. As strength and durability requirements became more strict the strong aluminum forging alloys became preferred materials. Increasing size of commercial and military aircraft, with engines of greater horsepower, pointed to the hollow steel propeller, and American know-how with materials was ready. The hollow steel blade saw service during the closing years of the war.

As more powerful engines were used to turn propellers of greater size, it became obvious that the forged aluminum alloy propeller had size limitations. The weight of a solid propeller is proportional to its volume, so that a small increase in the length of the blade causes a disproportionate weight increase. It

New forming and joining techniques have been developed to produce strong, light-weight propellers.

Movable furnaces are positioned under the hydraulic press, which forms shell and spar contours.

has been estimated that 13 ft. propeller diameter is about the practical size limit for solid propellers, even of aluminum alloy.

The Boeing B-29, for example, uses four-bladed propellers 16 ft. 7 in. in diameter. Using solid aluminum alloy blades, a propeller weighed 867 lb. The same propeller made with hollow steel blades would weigh 638 lb.—a saving of almost half a ton on a four-engined ship.

Development of the hollow steel blade was attended with numerous problems. When the blade's shell was made quite thin, to take full advantage of the hollow construction, the surfaces tended to flutter under heavy load. Use of an internal spar permitted lightening of the shell without loss of longitudinal rigidity, but brought the difficulty of forming a sure and secure bond between shell and spar. Some danger of flutter in local areas also remained.

A blade recently developed by Hamilton Standard Propellers Div. of United Aircraft Corp. solves these problems by an unusual combination of materials, and with the help of several unusual processing methods. It is made with a heat-treated alloy steel shell, an internal steel spar silver-brazed to the shell, and a light-weight filling of foamed vulcanized synthetic rubber to provide local rigidity for the shell. In addition, several important features have been made possible by the new construction. A de-icing system can be incorporated into the synthetic rubber filling along the leading edge of the blade, offering a considerable gain aerodynamically over the rubber boot applied externally to prevent icing.

Chromium-nickel-molybdenum steel is used for the shells and spars of the hollow steel blade. Fabrication of the shell starts with sheet stock, with the two sides of the shell blanked out and formed in the opened position about a common edge. This is done on presses between mating dies in the usual way. The two sides are then folded upon each other to form the shell, and the open edges are welded in a seam welder of the stored-energy type. Trimming completes the preliminary forming of the shell. A copper alloy bead is applied to the leading edge of the shell to increase its wear and corrosion resistance.

The spar is formed from an alloy steel forging. It is first lengthened, partially flattened along its length toward the tip, and tapered. This is done as a cold rolling operation.

It was at this point that Hamilton Standard's engineers found it necessary to devise new techniques and new equipment to produce the propeller blade they had designed. The shell had to be:

(1) formed to surface contour;
(2) treated to restore any carbon lost from the metal through heating or transportation in a heated condition;
(3) heat treated to develop best strength properties, and
(4) securely attached to the internal spar.

The last-named was particularly important, as the spar was to be the principal load-carrying member in the blade design. The most difficult processing problem was to plan the operations requiring heat so that they would not interfere with one another. For example, the forming of the shell should be done hot, it was decided; heat treating and carbon restoration would require a furnace treatment, and the bonding of shell to spar must be done without decarburization or destruction of the strength obtained by the heat treatment.

To form the thin metal that comprises the shell, with its low heat retention, a special type of furnace and press combination was built. Three furnaces, each with six retorts to permit use of controlled atmospheres, were mounted on car rails in a pit. Over the pit the forming press was installed. The propeller blade shells are charged into the retorts, in which a slightly carburizing atmosphere is maintained to restore any carbon loss in the surface layers of the alloy steel. Each blade is suspended from a retort cover. When the press is ready to receive one of the pieces, the furnace is moved so that the retort containing the shell ready for forming is positioned under the opening leading to the forming dies. Limit switches fix this position. With the retort opened, the shell is lifted at once to the press, is placed between the dies, and formed between the closed dies. Movement of the shell from the retort to the dies requires about 10 sec.

The furnace is propane fired, using many small burners to obtain uniformity in heating. Temperature is slightly above 1600 F. Propane is used for the carburizing atmosphere also, in a mixture of this gas with air, reacted in a separate building and fed to the retorts. The atmospheric gas is passed over lithium cartridges as it enters the furnace. The pipes carrying both the atmospheric gas and the combustion gas are equipped with flexible joints to permit movement of the furnace. Exhaust gases are carried away through ducts so arranged that discharge ports open to connect with the proper duct as the furnace moves from station to station.

In order to form the thin steel to the desired contours with high accuracy and without danger of collapse of the shell, the shell is expanded by internal gas pressure after the dies have closed, filling the cavity. A flexible steel diaphragm is used to seal the inboard end of the shell, still attached to the retort cover.

Forming of the spar is somewhat less involved than for the shell. Starting with the tubular forgings, from which any decarburized surface has been removed by machining, the diameters and wall thicknesses are tapered by cold rolling. The spar goes to the controlled atmosphere furnaces, therefore, without the need for carbon restoration, and a neutral atmosphere is maintained for protection only. The spars are similarly handled in the moving furnaces and the overhead press, except that the inboard end of the spar is threaded, and is screwed to the muffle cover to transfer gas pressure for expanding in the dies.

Joining of the internal spar to the shell required considerable study and experimentation. Silver brazing was decided upon as the best bonding method. A silver brazing alloy is placed along the upper and lower sides of the spar as strips of foil, and the shell is slipped over the stiffening member. The pieces are then placed between the dies of a hydraulic press, and sufficient gas pressure is applied internally to hold the shell against the dies, which are electrically heated. The brazing alloy is fused and the contours of the blade are corrected in this operation.

As the strength of the blade depends a great deal upon the firmness and continuity of the silver brazing, which is inaccessible to visual inspection, an electrical conductivity device has been developed to test the bond. A pair of contactors form one arm of a bridge circuit, and when the external surfaces of the blade are stroked with the contactors over the bonded areas, high conductivity indicates complete bonding.

With the metal portions of the blade assembled, the internal surfaces are treated with a protective cement. To provide local stiffening of the blade areas not in contact with the spar, a lightweight filling of synthetic rubber is next introduced. If de-icing is to be used, a network of fine wires is placed inside the shell along the leading edge of the blade, to be connected with the electrical system of the plane during flight and serve as a resistance heating element. The remainder of the cavity is filled by processing the synthetic rubber compound, inserted as strips, between vulcanizing dies heated by steam to 300 F. Both a foaming compound and the vulcanizing agents are included in the rubber formulation, and, under the temperature of the vulcanizing treatment the rubber is swelled and foamed, then hardened. The result is a low-density material, rigid, and of adequate strength, that fills the irregular cavities completely, provides insulation for the electrical de-icer, and bonds well to the cement-coated metal walls.

Another innovation in propeller blades is the use of four grooves in the hub of the propeller blade itself as ball races for the bearing through which pitch is adjusted. These grooves are induction hardened.

Hamilton Standard engineers feel that the new-type propeller will prove to be a solution to many of the problems of propeller design in the large sizes. Aircraft propulsion by propellers is receiving competition from jet propulsion, especially in the high-speed military craft, and in planes for special purposes, such as the launching of large planes from carriers. The propeller, they say, is still the most efficient means of pulling cargo through the air at speeds up to and possibly beyond the velocity of sound, and they expect the new blade, permitting stronger, lighter-weight structures in the sizes heretofore excessively heavy, to demonstrate the possibilities of this standard means of air locomotion.

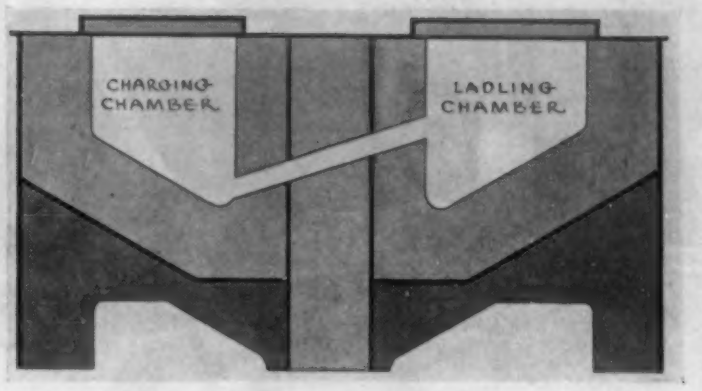
Aluminum die casting costs were reduced through use of this two-chamber induction melting furnace.

Closer control over melting and holding temperatures results in lower rejection rate and increased productivity.

Two-Chamber Induction Melting Furnace Lowers Aluminum Die Casting Cost

by **FLOYD J. KAMIN**, President, Kamin Die Casting & Manufacturing Co.

SIX MONTHS AGO we installed a new two-chamber electric low frequency induction furnace for melting and holding aluminum. This furnace, manufactured by the Fisher Furnace Div., Lindberg Engineering Co., replaced a conventional gas-fired crucible furnace also manufactured by Lindberg-Fisher, and has proven, we feel, to be an outstanding development in the aluminum die casting field. We recently



This schematic drawing shows the relationship between chambers of the two-chamber melting furnace.

installed a second furnace—have ordered a third, and in the near future plan to use this type of furnace for our entire aluminum melting operation.

In this furnace, two chambers are provided instead of the usual single chamber. One chamber (the charging chamber) is for receiving ingots or molten metal. This chamber is connected to a second chamber (the ladling chamber) by melting channels.

The second chamber, therefore, holds only molten metal—and ladling can take place continuously even though cold metal has just been added to the charging chamber. Within reasonable operating limits, the addition of cold metal to charging chamber does not lower the temperature in the ladling chamber.

We find that the unit is really two furnaces in one—eliminates necessity of having two furnaces and transferring metal from a melting furnace to a holding furnace.

Operating figures for the past six months show a 60% reduction in rejects, a 46% increase in production, only a 10% increase in melting cost, a 33% reduction in labor costs, and a 73% reduction in maintenance costs. These figures are based on a typical production run of lawn mower wheels.

In addition, the new furnace contributes greatly to the operator's comfort, as reduced radiation of heat from the furnace shell has resulted in a temperature drop of about 25 F in the immediate vicinity of the operator's station.

Also of considerable importance is the fact that initial cost of the new equipment (while higher than conventional types of fuel fired melting furnaces) is definitely not prohibitive. As a matter of fact, initial costs figured with savings and advantages mentioned above reduces costs per casting and puts us in a better position on a price basis when bidding competitively with other producers of die castings.

Rejects Reduced 60%

With our old gas-fired furnaces, temperature in the molten metal fluctuated from 25 to 50 F. Excess temperature frequently resulted from overheating of the crucible on the flame side. Temperatures at the surface of the molten aluminum were often too high because the flames bathing the furnace crucible would spill over the crucible edge onto the aluminum.

With temperatures alternately increasing and decreasing, it was difficult to maintain the correct operating temperature for the die. This, of course, caused high scrap losses and shorter die life.

The excessive surface temperature of the aluminum led to high gas absorption from moisture in the air and also from products of combustion. This made fluxing necessary. Another factor contributing to rejects was alloy segregation, which sometimes took place because there was no agitation of the metal during heating. That segregation took place was proved by the various deposits found in the bottom of the crucible.

With the new two-chamber induction furnace, temperature variation is reduced to a plus or minus 5 F. With a lower temperature constantly maintained, gas absorption from moisture in the air is minimized. Absorption from products of combustion is, of course, completely eliminated by the use of electric heat instead of gas heat, as is surface over-heating caused by gas flame spillover from the sides of the crucible.

The electro-magnetic fluxing of the induction furnace causes a gentle intermittent agitation of the molten aluminum, which helps maintain consistent structure throughout the aluminum, and minimizes alloy segregation.

Another advantage of the new furnace was that aluminum in the ladling chamber was almost completely free of foreign particles—all dross and residue remaining in the charging chamber, either floating at the surface or sinking to the bottom.

The lawn mower wheel previously referred to requires a 2½-lb. shot of molten aluminum at 1180 F. We operate on two 10-hr. shifts with an idling period of 4 hr., for a total of 24 hr.

Rejects with the old furnace frequently ran as high as 15%, compared to only 3 to 5% with the new two-chamber furnace, as shown in the following table.

	Old Furnace	2-Chamber Induction Furnace
Lb. Capacity	240	700
Casting Production Per 20 Hr. Day	812	1062
Rejects	121	53
Total Net Production	691	1009
Temperature Fluctuation	25 to 50 F	5 F
Total Lb. of Aluminum Melted Per 20 Hr. Day	2030	2655
Lb. of Aluminum Cast Per Hr.	101	132

As shown in the preceding table, net production after rejects increased from 691 lawn mower wheels to 1009—an increase of 46%. On this particular furnace, we get approximately 3.5 lb. melting per kwh., including holding losses.

Melting Cost Comparable

Our operating figures show that melting cost per lb. has been 27/100¢ with the old furnace and 30/100¢ with the new furnace. Here are the figures on which we have based our computations:

Electric Furnace

35-Kw. Furnace Rating—700 lb. Holding Capacity
Melting Rate 165 lb. Maximum

Power consumption per hr. for melting 132 lb. of aluminum, including radiation losses, is 32 kw. x 20 hr. (daily operation)	640 kwh.
Power consumption during 4 hr. idling period each day. 4 hr. x (12 kw. radiation loss)	48 kwh.
Total 24 hr. consumption	688 kwh.
688 kwh. per day x 6 days =	4128 kwh.
24 hr. week-end idling x 12 kw.	288 kwh.
Total weekly power consumption	4416 kwh.

132 lb. per hr. x 20 hr. a day x 6 days a week = 15480 lb. melting production per week

15,840 lb. ÷ 4416 kwh. = 3.58 lb. per kwh.

Power rate, 1.08¢ kwh.
Melting production per kwh., 3.58 lb.
Melting cost per lb.—30/100¢

Gas Furnace

Our melting cost with a conventional type gas fired furnace (250 lb. crucible) is 27/100¢ per lb., as shown below.

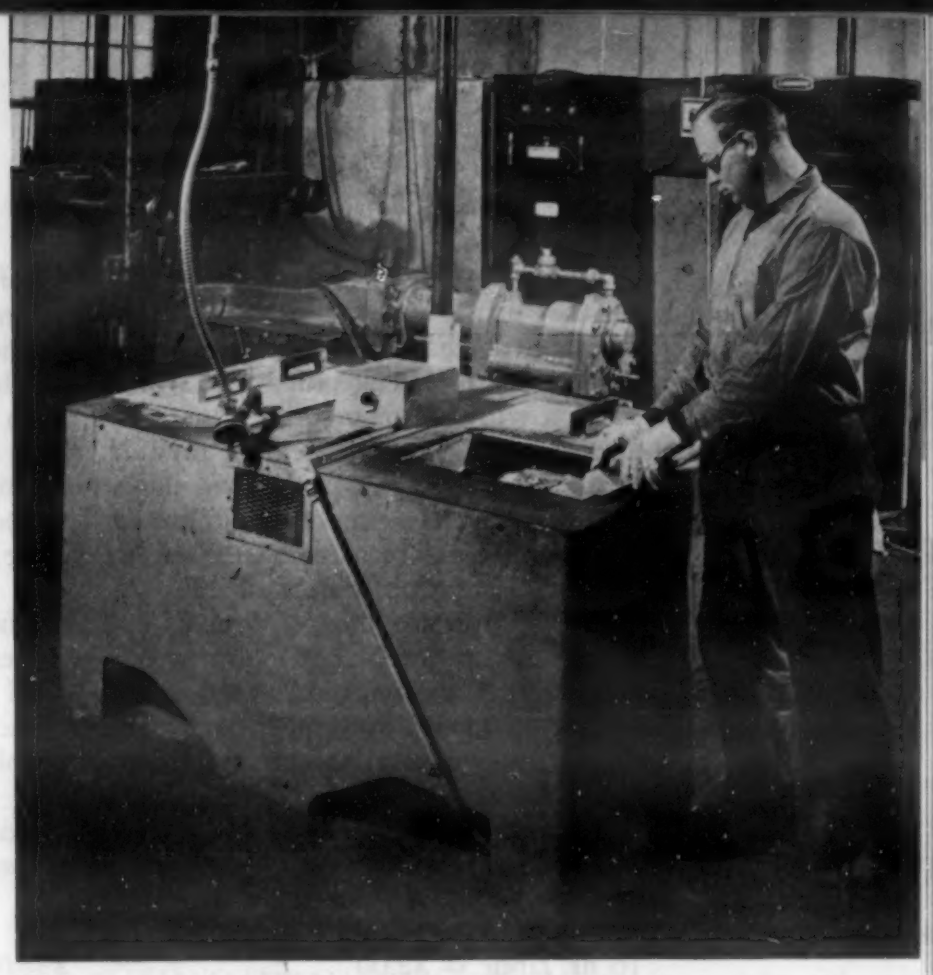
Gas consumption per hr. for melting 101 lb. aluminum. 320,000 Btu. 3.2 Therms	
Gas consumption for 20 hr. operation	64.0 Therms
Gas consumption for idling 4 hr. @ 120,000 Btu.	4.8 Therms
Total 24 hr. consumption	68.8 Therms
68.8 Therms per day for 6 days	412.8 Therms
Starting up consumption (after week-end shutdown) 600,000 Btu.	6.0 Therms
Total weekly fuel consumption	418.8 Therms

12,120 lb. ÷ 418.8 Therms = 28.9 lb. per Therm
101 lb. melted per hr. x 20 hr. a day x 6 days a week = 12,120 lb. melting production per week

Fuel rate, 7¾¢ per Therm
Melting per therm, 28.9 lb.
Melting cost per lb., 27/100¢

Labor Cost for Casting Reduced 33%

Savings effected from the reduction of labor costs (resulting from increased production) ran at $108 a week, enough to pay for the new two-chamber furnace in slightly less than 8 months. These figures are based on the "lawn-mower" wheel job cited. This casting requires a 2½-lb. shot of molten aluminum at 1180 F. As shown in the table below, labor cost per casting has dropped from 57/10¢ to 39/10¢.



Addition of cold metal does not affect molten aluminum in the ladeling chamber of the two-chamber melting furnace.

Old Equipment	New Equipment
Overall labor cost per day (approx.) 20 hr. at $2. an hr.—$40.00	Overall labor cost per day (approx.) 20 hr. at $2. an hr.—$40.00
Casting run per 20-hr. day —691	Casting run per 20-hr. day—1009
Labor cost per casting—5-79/100¢	Labor cost per casting —3-90/100¢

Labor cost savings per casting (5.79¢—3.90¢)	1.89¢
Labor cost savings per day (1009 castings @ 1.89¢)	$18.16
Labor cost savings per 6 day week	$108.96

Maintenance Cost Reduced 73%

Our maintenance savings have been reduced to a great extent. With our old equipment we found it necessary to replace crucibles 8 times a year, and for best efficiency a reline job was done once a year. A minimum of 12 thermocouples were used each year. As shown below, our total annual maintenance cost ran at $524.

8 new crucibles @ $37.00.....	$296.00
1 reline job	
refractories $100.00	
16 hr. labor $ 32.00.....	$132.00
12 thermocouples @ $8.00.....	$ 96.00
(This does not include labor for daily coating)	
Total	$524.00

The two-chamber furnace, instead of using crucibles, is completely refractory-lined with a replaceable

cast refractory. Thus, we eliminated the cost of the eight crucibles required each year for the old furnace, plus any cost that might be involved in providing storage space for stock crucibles. After 6 months of operation with the new furnace there is no sign that the refractory needs replacement now or in the near future. We feel that it probably will last as long as 18 months, and certainly a minimum of 12 months. Being an electric furnace, there are, of course, no gas or oil burners to replace or adjust.

The new furnace uses a porcelain thermocouple tube which has completely eliminated the necessity of coating the thermocouple each day to avoid any iron pick-up (from the iron thermocouple protection tube). So far we have had one thermocouple replacement.

Thus, our total annual maintenance cost consists of a reline job and thermocouple replacement, costing a total of $140, as shown below.

16 hr. labor @ $2.00	$32.00
1600 lb. of Marvex Castable Refractory @ $.0525 per lb.	$84.00
Two thermocouples (estimated) @ $12.00	$24.00
Total	$140.00

In discussing electric melting furnaces, one question that usually arises is that of freezing as a result of power failure, etc., and consequent possible damage to refractory. The one and only "freeze-up" that we experienced came as a result of a fuse failure. We found that by placing two burners—one firing directly over each chamber—we could create a molten top to each chamber in a short period of time. This molten aluminum will leak into the channels between the two chambers, and fill up voids or shrink-gaps, thus completing the electrical circuit. It has been our experience that with our 700-lb. load, it was completely remelted and ready for ladling in about 5 hr.

Recently, when we decided to install additional power lines in our plant, it became desirable to shut down the furnace after 6 months of continuous operation. To do this we removed approximately half of the molten metal from the furnace (to a point lower than the melting channel in the ladling chamber), allowing the remaining metal in the furnace to solidify.

To resume operation we hot-charged the furnace with about 50 lb. of molten aluminum in the ladling chamber, turned on the power, and gradually added cold ingots.

Metal was completely molten, and furnace was back in normal operation in less than two hr.

Operating Advantages

As mentioned before, the new furnace is much cooler to work, from the operator's standpoint. The heat radiated from our gas-fired furnaces not only made work extremely uncomfortable for the operators, but increased the temperature of the entire shop. During the summers we noticed a great drop in operator efficiency. In a number of instances it was necessary to send operators home because of the intense heat.

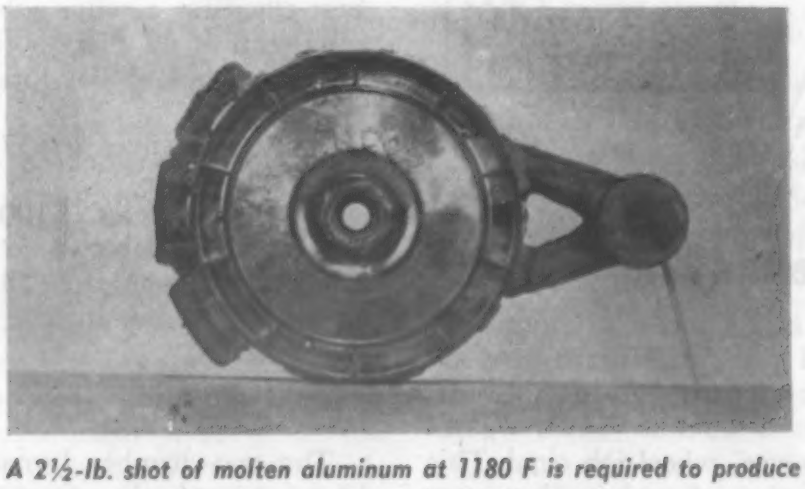
In checking actual temperatures in and about the operator's station, we found temperatures as high as 115 to 120 F on several occasions. With the new two-chamber induction furnace, we find the operator's stations to be about 25 F cooler.

This is because with induction heating only the aluminum is heated, not the entire furnace. Only a comparatively small area of the molten aluminum is exposed to the ladler.

We also found that we were free from the fire hazard that in some instances exists with gas installations, not only because of gas leakage, but also because of crucible breakage, causing full loads of molten metal to be spilled on floor.

The original cost of the two-chamber induction furnace is admittedly higher, running $3350, as compared to $1117 for a gas-fired unit. However, overall costs in the long run are less when we take these items into consideration:

1. Rejects reduced 60%
2. Production increased 46%
3. Melting cost increased only 10%
4. Maintenance cost reduced over $384 annually
5. Labor cost reduced 33%
6. Safer
7. Better working conditions for operator



A 2½-lb. shot of molten aluminum at 1180 F is required to produce this lawn mower wheel die casting.

The stainless steel precision casting at right replaces a carbon steel sand casting (left), which required machining away of 1¾ oz. of material.

Precision Cast Stainless Steel Electrical Parts Reduce Weight, Save Costs

by **H. C. AMTSBERG, Manager, Metallurgical Engineering, Materials Engineering Dept., Westinghouse Electric Corp.**

THE WESTINGHOUSE ELECTRIC CORP. is using precision castings to considerable advantage in breaking production bottlenecks, improving quality, and decreasing cost in the manufacture of circuit breaker equipment. The latching pawl for a Type "DA" air circuit breaker, shown in the accompanying illustration, is a typical example.

In the past, the company purchased either plain carbon or stainless steel sand castings, for industrial or Navy application, respectively, and machined and heat treated these to prepare them for assembly into the breaker. Considerable difficulty was encountered in obtaining castings of suitable quality; 10 to 20% of them were invariably rejected at considerable expense when final machining revealed shrinkage defects. Seven machining operations, a heat treatment, and an electroplate (on the carbon steel casting) were necessary in order to prepare this casting for use. The part at the left in the illustration shows this casting as received from the supplier, while the center view illustrates the casting after it has been completely machined, treated and plated. The weight of the casting is reduced from 5¾ oz. to 4 oz. in machining. An inventory of approximately $2,000 worth of tools, jigs, and fixtures was necessary for the machining operations.

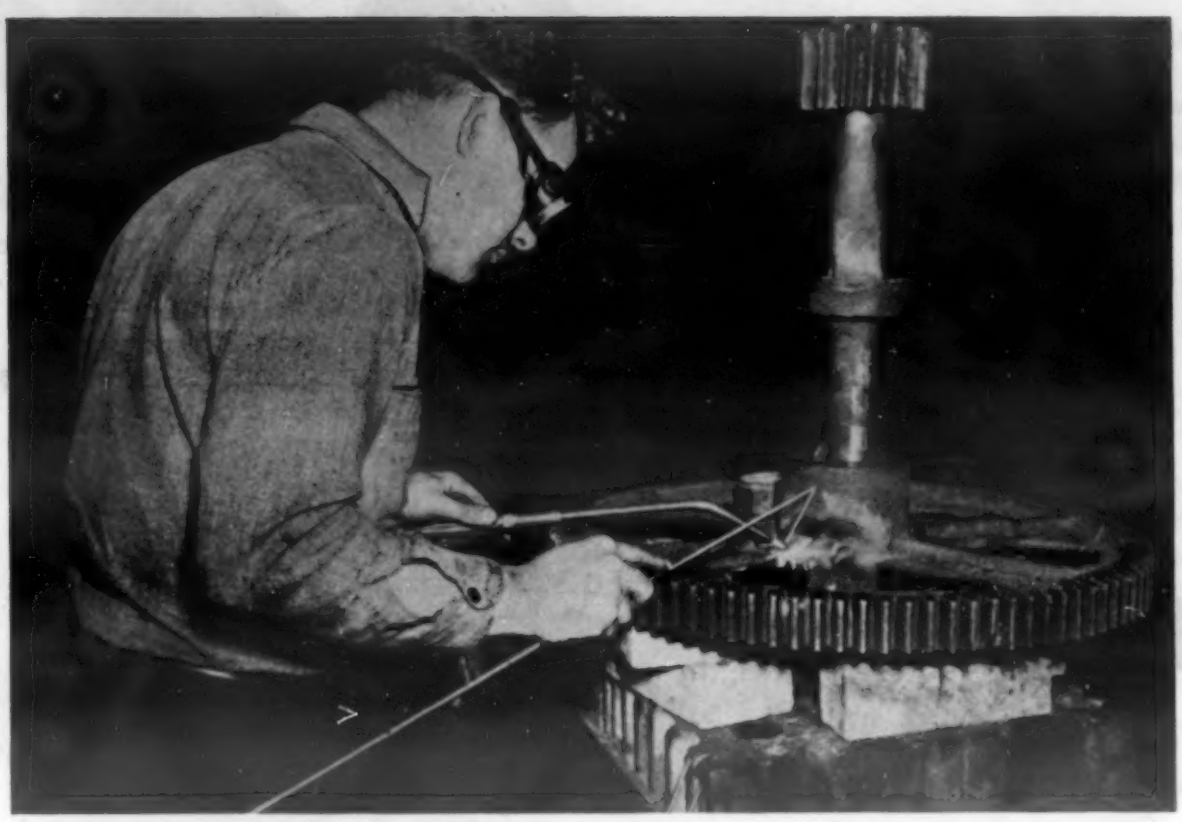
The part at the extreme right in the illustration shows this part precision cast by the "lost wax" investment casting process. The latter part is shown just as it was cast, with the exception of cutting off and grinding of the casting gate and a sand blast. The surface finish is in the order of 80 RMS. The piece cost of the precision casting is 25% less than the machined carbon steel sand casting and 42% less than the stainless steel one. It requires only a reaming operation of the large holes, costing an additional 2% to prepare it for use. Its weight is only 2½ oz., although section thicknesses are equivalent where needed. Its as-cast strength and hardness (approximately 30 Rockwell C) are more than adequate for the application. Shock resistance has been conclusively demonstrated to be far beyond anything to be encountered in actual service.

Original tooling and engineering costs for the precision casting were $500. An additional $200 for master pattern correction and additional wax injection dies completed the tooling for this item. It has been found good practice to make one wax injection die from an initial master pattern, which incorporates the best estimates of dimensional changes that will occur in the process due to wax and metal shrinkage and distortion. Sample parts are produced, accurately measured, and a statistical distribution of the data prepared. These data will generally indicate the corrections required in the master pattern, and one such change usually suffices to bring the dimensions of the casting within the range required.

The precision casting for this application is made in stainless steel for both the industrial and Navy use. Melting costs of high grade material are relatively less expensive in the inherently high cost practice employed in investment casting than is the case in conventional large volume melting.

It is perfectly obvious that the precision casting provides a much more workmanlike part in every respect. Its streamlined appearance offers eye appeal, the reduced volume permits the design of more compact apparatus, its lesser weight reduces inertia in breaker operation, and the part is corrosion resistant throughout. These features are over and above the direct cost saving.

The precision casting shown was produced by the Westinghouse Precision Casting Laboratory, East Pittsburgh, Pa.



Bronze welding was used to repair this badly damaged cast iron gear, because it took less preheating and the welding was faster.

Bronze Welding or Fusion Welding for Repairing Cast Iron?

by H. B. GILSON, The Linde Air Products Co.

BOTH FUSION WELDING and bronze welding can be used for welding broken iron castings; and both methods have advantages. The purpose of this article is to give information that will help in the proper choice of method for a particular job.

There are several basic differences between bronze welding and fusion welding that must be understood. In bronze welding, the casting is not melted. Except for the area along the line of weld, the casting usually is heated to a temperature of 600 to 800 F. The metal along the line of weld is heated to about 1000 F, or until it just turns a very light red in daylight. Because the temperature is so low, usually only local preheating is needed. Expansion and contraction stresses will not cause trouble.

Proper choice of repair welding method depends upon type of cast iron, processing factors, and service conditions.

The base metal is melted in fusion welding. The beveled edges melt and the vee is filled in with molten metal from a cast iron welding rod. A high temperature, about 2200 F, is needed to melt the casting along the line of weld. Because of the high temperature, the rest of the casting must usually be preheated to 1000 to 1200 F. This prevents setting up stresses that might crack the casting later. In fusion welding the part is actually recast in the welding groove. The weld metal has approximately the same color, composition, and machining characteristics as the original part.

Whether bronze welding or fusion welding is used,

broken gear case casting was fusion welded because a color match was desired and the crack would have been extended by local preheating.

the joints are prepared by beveling the edges to form a 90-deg. vee. After the welding operation, the cooling procedure is also the same. Large parts must be covered with asbestos paper to protect them from drafts; small castings can be buried in dry sand, slaked lime, dry asbestos cement, or some other insulating material.

Selection Considerations

Type of Cast Iron—The first step in selecting the proper welding method is to identify the type of cast iron. This is important because there are three common types—white cast iron, gray cast iron, and malleable iron. Special treatment during production gives each type special qualities. When molten iron is cooled rapidly, white cast iron is produced. It is hard and brittle and the fracture has a white color. When the molten iron is cooled at a slower rate, gray iron is produced. Gray iron is softer, less brittle than white iron, and it is easy to machine. The fracture has a dark gray color. If a casting is suitably annealed for several days at a temperature well below the melting point, malleable iron is produced. Malleable iron is ductile and can be machined easily. It is used for such things as pipe fittings, farm equipment, household hardware, brackets, lugs, ratchets, and all kinds of machinery.

Welds in white iron usually are not satisfactory. Unless the part is specially treated after welding, it will lose its wear resistance at the weld. This type of casting is not often encountered, but when it is, use fusion welding.

Either fusion welding or bronze welding can be used on gray iron castings. The need for a color match, and the temperature at which the part will be used will influence the choice. Always bronze weld malleable iron. The heat of fusion welding would

destroy the malleability and make the casting brittle.

Temperature—Where the parts are to operate at temperatures under 500 F, fusion welding or bronze welding will be equally satisfactory. However, bronze loses strength at temperatures over 500 F. When the part will be heated in service to this temperature or higher, use only fusion welding.

Color—When a gray iron casting breaks and a color match is important, you must fusion weld.

Previous Use—Fusion welding is also the best method for repairing "poisoned" castings, such as oil-soaked machinery and brine-soaked castings.

Finishing Operations—If the weld will be machined, tapped, or threaded, fusion welding usually is preferable. Fusion welding is also used when the casting will be enameled or glass-coated. However, when rebuilding and shaping gear teeth, bronze welding is the way to do the job.

Preheating—In fusion welding the entire part should be preheated in a furnace. Otherwise the high heat at the weld zone and the low temperature of the rest of the casting will set up stresses and cause new cracks. Whenever it is impossible to build a furnace, the blowpipe can be used for local preheating and the job done by bronze welding.

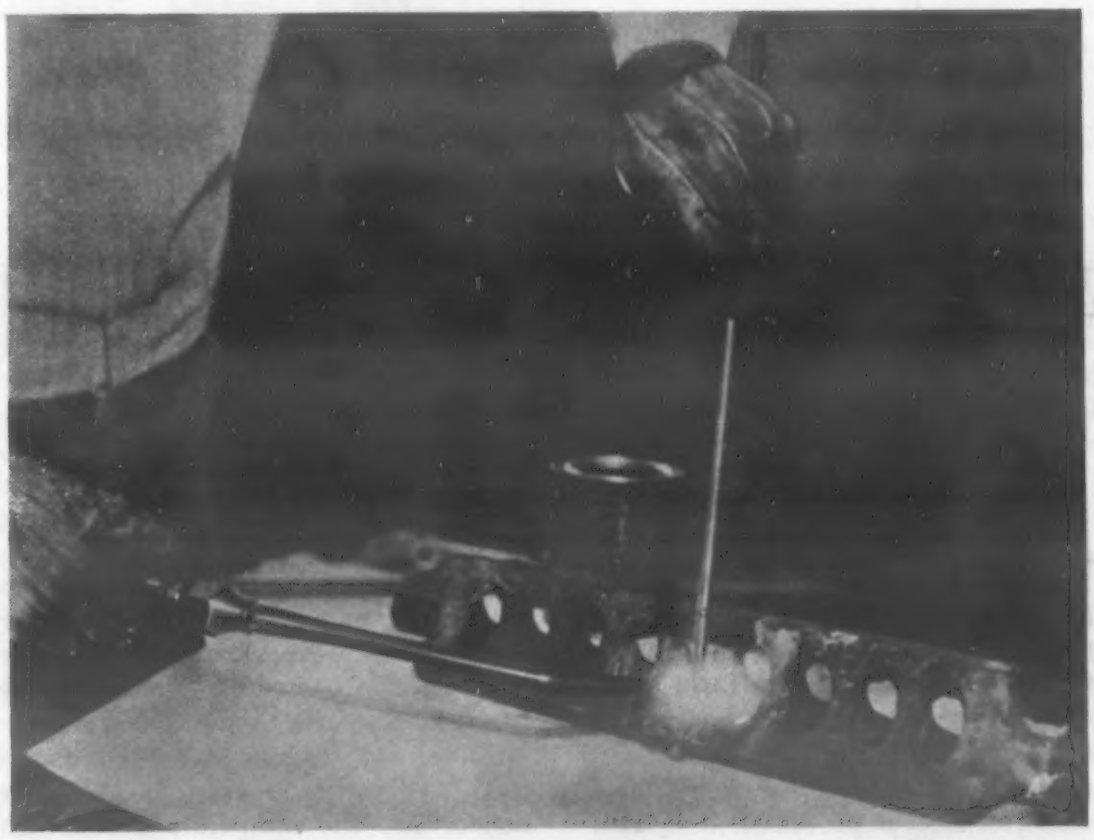
Two Typical Jobs

Here are two typical repair jobs—one was bronze welded and the other fusion welded. They show why the welding method was chosen and how the job was done. The first involves bronze welding a reducing gear for a steam shovel. Fourteen teeth were broken and all spokes were cracked. The spokes were cracked close to the shaft in such a way that the gear could not be removed. Bronze welding was decided upon for two reasons. First, the gear was needed in a hurry and bronze welding is faster because it takes less preheating. Second, it would have been necessary to preheat both the shaft and gear for fusion welding, and it was impractical to build a furnace to do this job.

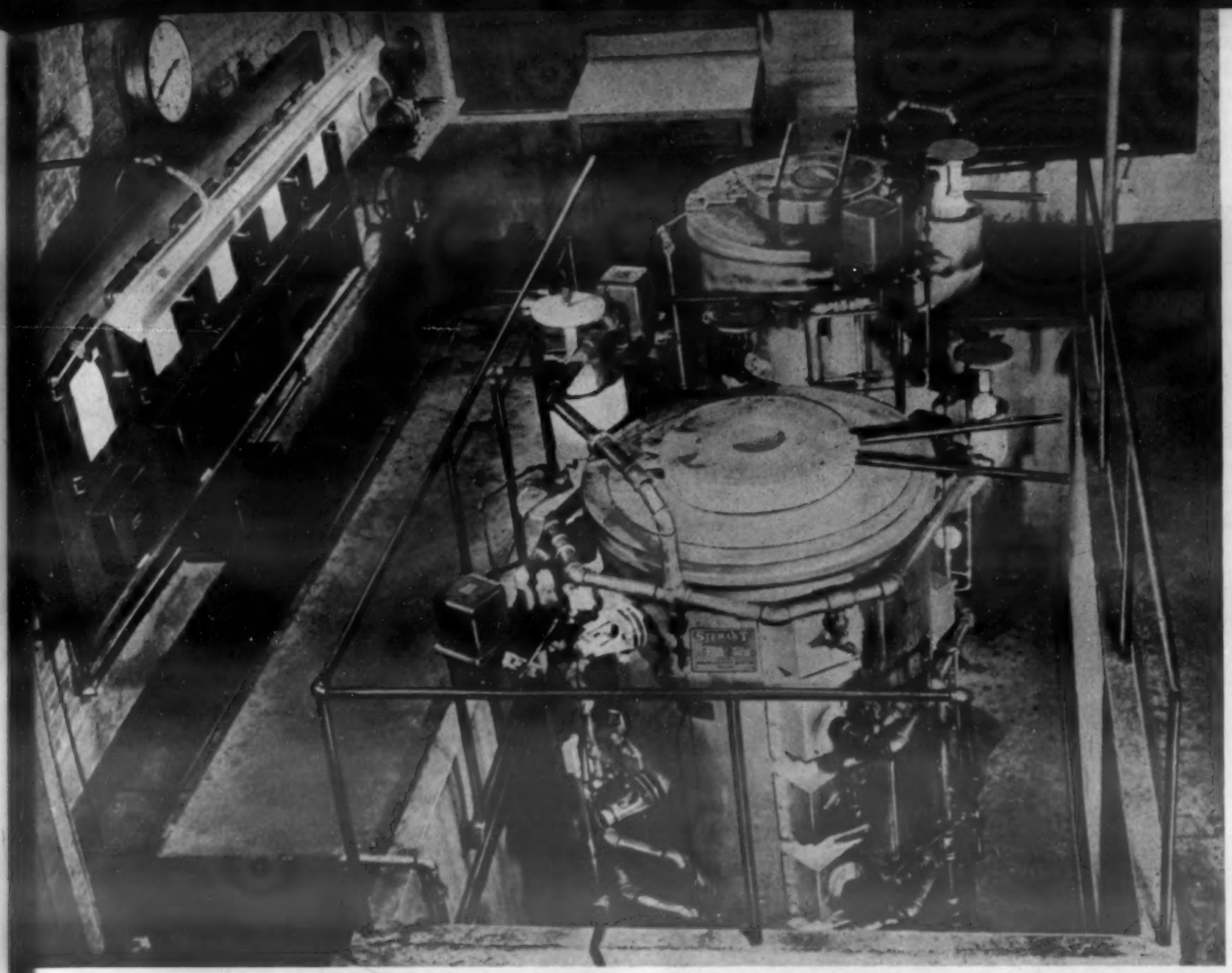
This is how the welding was done. Two opposite spokes were ground on each side. Sections that couldn't be reached with the grinding wheel were chiseled. The operator then aligned the gear and the shaft and tack-welded the two spokes with bronze welding rod. After the rest of the spokes were ground on both sides, all the spokes were bronze welded. The broken gear teeth were then ground and rebuilt with bronze.

The second case involves fusion welding a broken gear case. Tests showed that the part was gray iron. The crack was on the top of the casting and was Y-shaped. It would have spread farther under local preheating, and, in addition, a color match was desired. Therefore, it was necessary to preheat the entire casting and do the repair by fusion welding. With full preheating, bronze welding could have been used, and the preheat temperature could have been lower if a color match had not been required.

The cracks were ground and a temporary firebrick furnace was built. The casting was placed in position and preheated by a charcoal fire. Welding was started when the temperature reached 600 F. The branches of the "Y" were welded first and then the "tail." As soon as the weld was completed, the top of the furnace was completely covered with asbestos. The fire was then left to burn itself out and the casting was not moved until it was completely cold.



Castings like this broken grate bar are repair welded by fusion welding because bronze welds lose strength when heated above 500 F.



Sunbeam Stewart vertical high-speed hardening furnaces used at La Pointe Machine Tool Co., for hardening broaches 80 in. long and up to 7½ in. in dia.

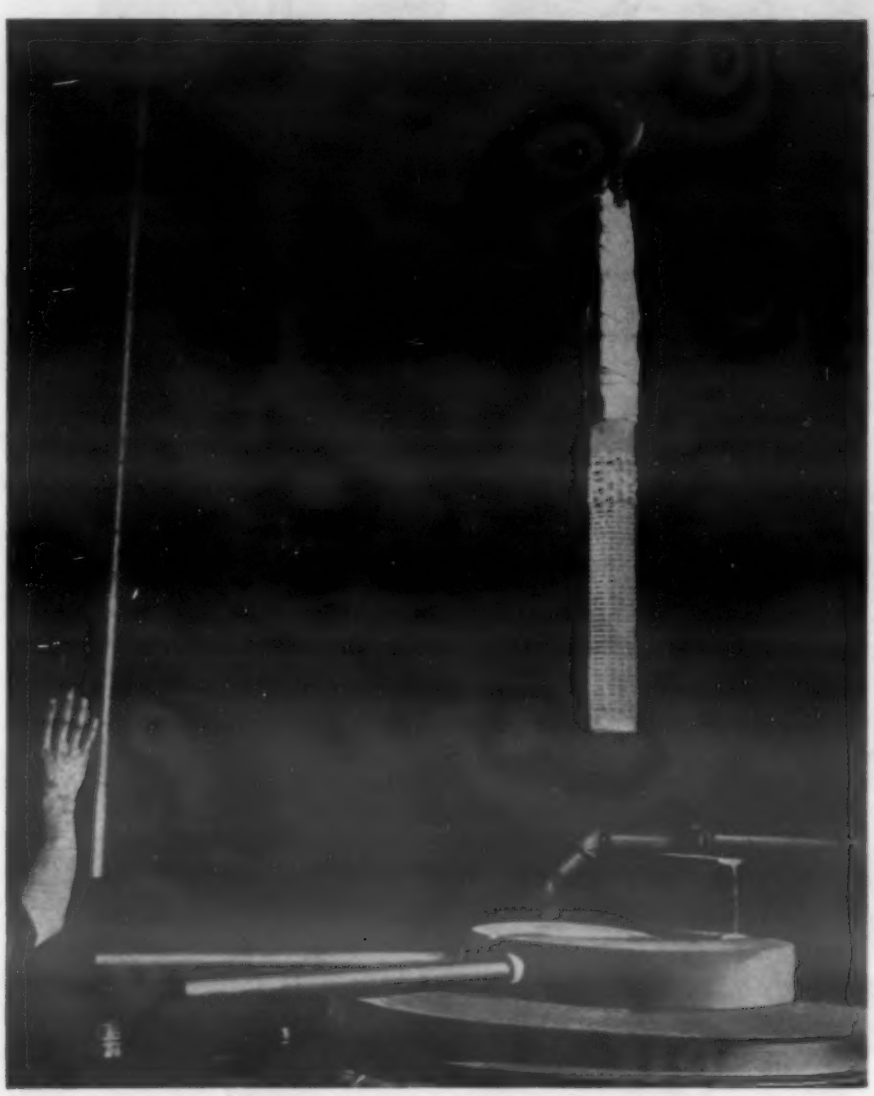
Broaches, being long and thin and having abrupt changes in cross-section, require rigid control to avoid distortion and keep stresses at a minimum.

Vertical Furnaces Reduce Labor Costs 20% In Treating High-Speed Steel Broaches

by **W. L. GIBBONS, Chief Metallurgist, La Pointe Machine Tool Co., Hudson, Mass.**

ELIMINATION OF SCALING, decarburization and distortion are important in the hardening of high-speed steel broaches at the La Pointe Machine Tool Co. The design of these pieces is such that there are abrupt changes in cross section which cause an out-of-balance condition of internal stresses—making broach hardening an exacting operation.

A brief description of the broaches heat treated



Broach being removed from hardening furnace preparatory to quenching.

Quenching the broach. Broaches are suspended vertically in the furnace and quenched in the same position to hold distortion to a minimum

are as follows: The smallest tool hardened is 0.031-in. dia. by 2-in. long; the longest, 7½-in. dia. by 80-in. long. Rectangular tools vary from 0.030 by 0.060 by 3-in. to 7 by 3 by 90-in. long.

Through the use of vertical hardening furnaces installed in pits with overhead hoists for loading and quenching, La Pointe has reduced the amount of stock necessary for grinding after hardening from an average of 0.075-in. to an average of 0.035-in., plus blueprint size. This reduction in stock left for grinding resulted in a tremendous saving in grinding time and wheel cost. The operating cost of a set of two preheat and one super-heat furnace (operating at 1600 F and 2350 F, respectively) is 39¢ per hr. for fuel oil while hardening an average load of 960 lb. of 18:4:1 high-speed steel hourly.

Labor savings experienced with this type of equipment amounts to approximately 20%.

As for the finished products, La Pointe has found that this installation has reduced straightening operations 50%. There have been no rejections due to scaling or improper hardness values. The tool quality has improved immensely due to the consistency of atmospheric and temperature control. Close metallurgical control has been maintained continuously with a resultant high quality in the finished tool.

All broaching tools of the 18:4:1 type are preheated at 1600 F, after which they are transferred to the superheat operating at 2350 F. The holding time on repetitive tools, when established, is indicated by an interval timer, which rings a bell on completion of the austenitizing cycle. So many and varied are the tool sizes and designs, it would be impossible to make mention of them all here. Heating cycles are arrived at by visual inspection through an observation port provided for that purpose into the heating chamber, and also by the use of an optical pyrometer. The observation port is sealed and covered with a disk of pyrex glass. The Leeds & Northrup ray-o-tubes used for control also indicate when the tool is approximately up to quenching temperature. A further examination by the laboratory makes certain that the proper austenitizing temperature is obtained during the heating cycle. It is only through highly accurate temperature and atmospheric control, together with uniformly heated furnaces, that such results can be repeatedly obtained.

This installation is also used for the heat treatment of large sections up to 7 by 5 by 80-in. of high

ere the operator is drawing the tang end of a broach in a Sunbeam Stewart salt bath furnace.

A 7½-in. dia. by 80-in. long broach being removed from Super-heat.

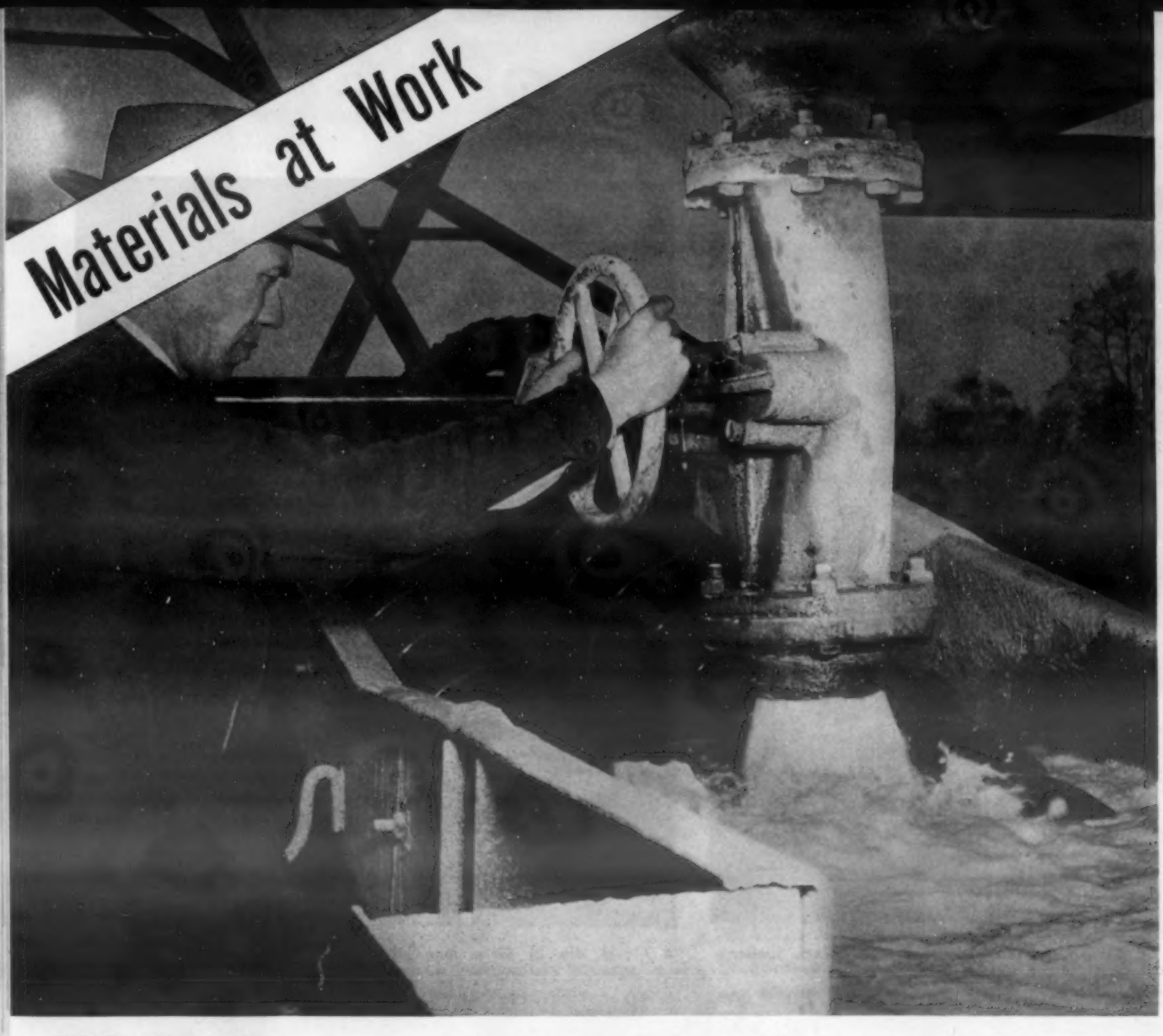
carbon, high chromium air hardening steels which are austenitized within a range of 1750 to 1800 F. Such grades as SAE 4130, 4150, 1050, and 1095, and carburized grades such as SAE 4615, 2320 and 3120 are also successfully heat treated.

All tools and parts hardened in these furnaces are suspended vertically by special holding fixtures or wire. A load consisting of several sections can be heat treated at one time by the use of cross rods laid along two special rails provided for this purpose. The austenitizing cycle for our high-speed steel tools is carried out by transferring each tool separately—by means of an overhead electric hoist—into the super-heat furnace. An oil quenching tank 48-in. in dia. by 12 ft. deep is used for the quenching operation and is maintained at 150 F. After quenching to approximately 900 F, all broaching tools are straightened to within 0.010 in. before they reach 350 F. Upon reaching room temperature, the tools are placed in tempering furnaces operating at 1050 F. The tempering cycle is carried out on the basis of 3 hr. per in. of cross section. After tempering is completed, any tools requiring further straightening are worked on while still hot and until they cool to 400 F. A light sand blast, using beach sand, is performed as a final operation before leaving the hardening room.

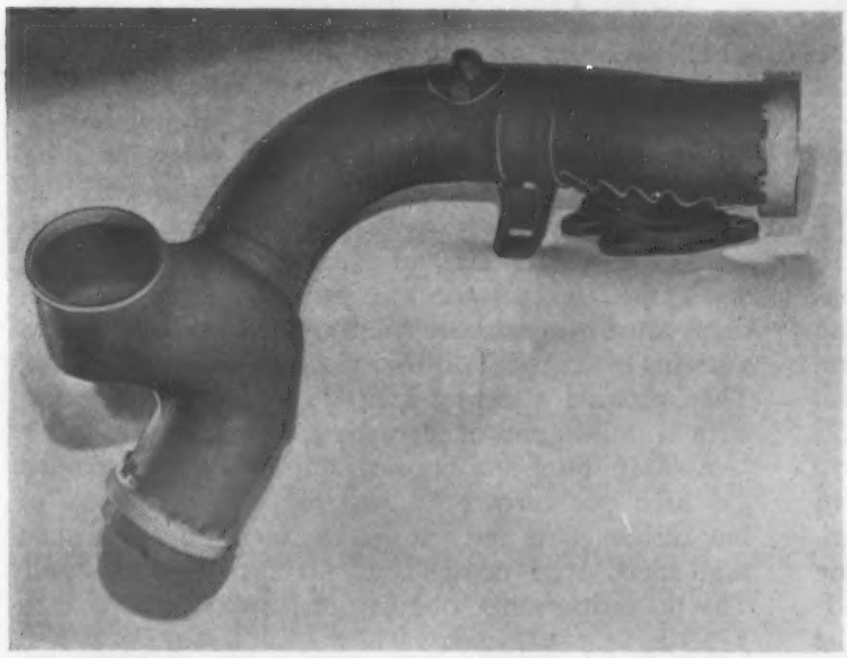
La Pointe's furnaces consist of a number of vertical muffle preheat furnaces and a vertical muffle high temperature furnace. The usable heating space is 12-in. in dia. by 80-in. deep. In addition, numerous semi-muffle oven type furnaces are employed, ranging in size from 30-in. wide by 72-in. long to one which is 48-in. wide by 105-in. long, and is fired by 16 gas burners which are supplied by two Sunbeam Stewart gasifiers and controlled by two ray-o-tubes and two micromax recording potentiometers. The work processed in the semi-muffle ovens consists of general heat treating of the various alloy steels, also annealing and normalizing of cast iron, and carburizing of the low carbon grades. All furnaces are equipped with Sunbeam Stewart gasifiers as a means of cracking oil into gas as a heating medium. They provide a desirable atmosphere for hardening with a minimum of decarburization and scale.

A 60-in. Sunbeam Stewart automatically controlled gas fired pot furnace is used for case hardening of low carbon parts and also for the nitriding of finished high-speed steel broaches in an aged cyanide bath. The operating range of this pot furnace is 1000 F to 1750 F.

Materials at Work



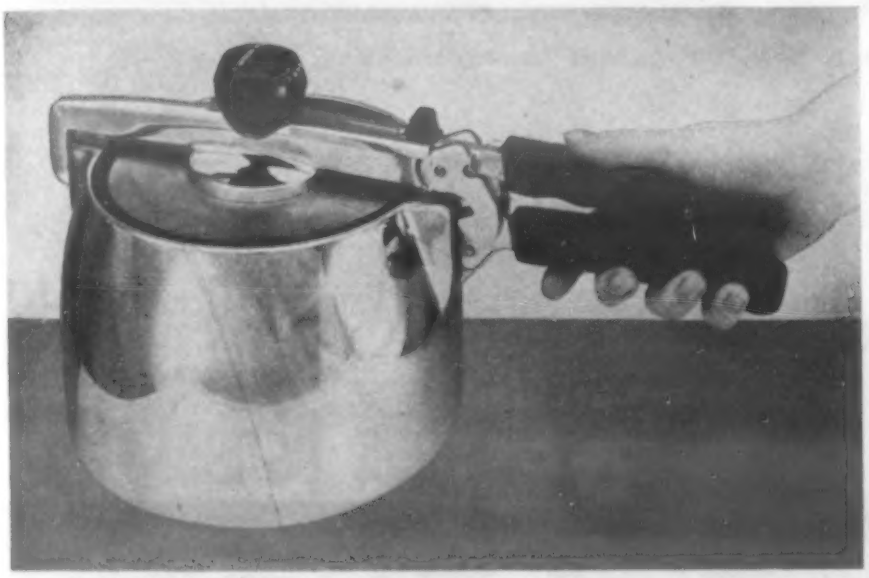
RUBBER LINED VALVE *The valve shown in the accompanying illustration handles silica sand suspended in water. Cast iron valves previously used were worn out by the abrasive action of the sand at such a fast rate that operations of the sand quarry were impeded. By lining it with rubber, life of the valve has been extended to the point where the valve shown has handled well over 21,000 tons of the suspended sand during the past six months. (Photo: Courtesy B. F. Goodrich Co.)*



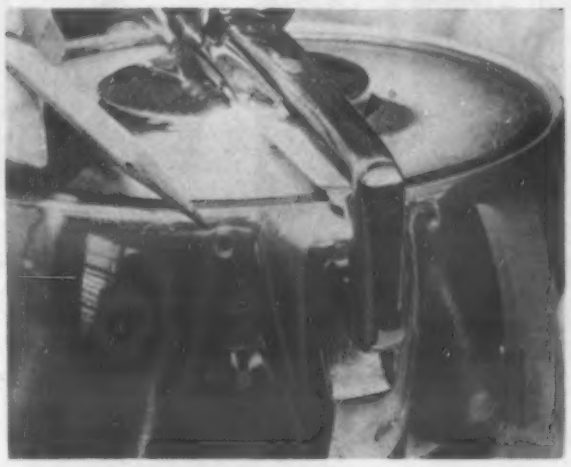
COMPLEX PIPE ASSEMBLY USES THREE STEELS

Three different types of steel are specified in this gas intake pipe for the Pratt & Whitney R-4360 aircraft engine. The pipe bodies are formed from strip nickel-chromium-moly steel; scalloped reinforcing skirts are low carbon steel; and, flanges are forged and machined stainless steel. Parts forming the body were assembled by torch welding and the skirts, flange, bracket and threaded adapter assembly silver-soldered to the pipe. Specifications required that the formed and welded parts be held to aircraft accuracies. Flange and bracket surfaces are parallel to within 0.003 in. and the same tolerance applies to flange surface flatness. The assembly is produced by B. H. Aircraft Co., Farmingdale, N. Y.

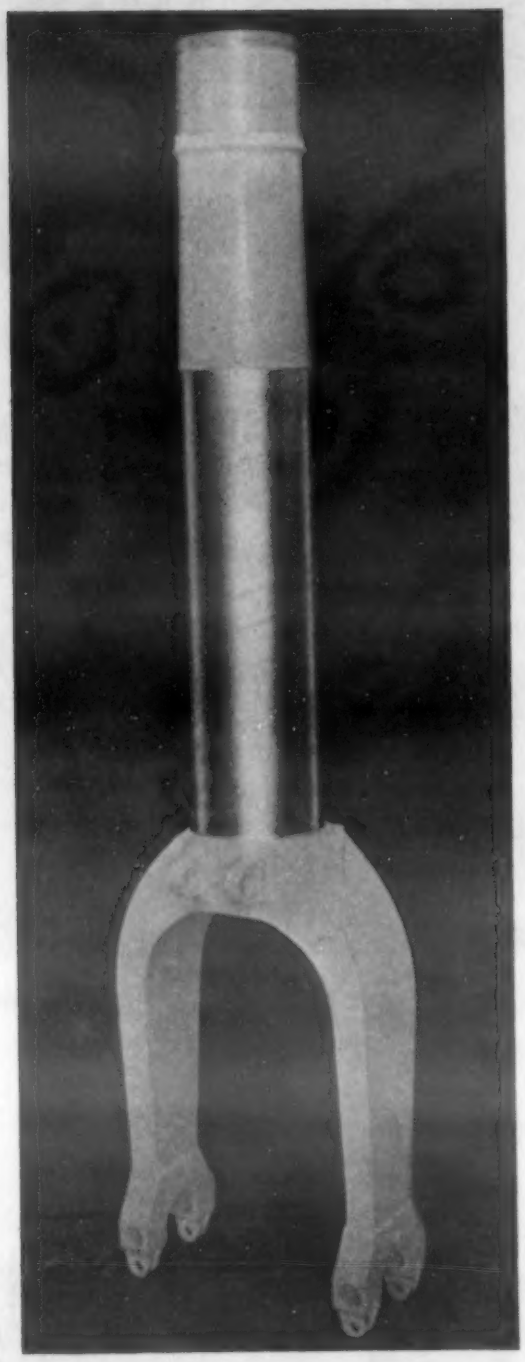
—A special feature devoted to showing how materials are used as well as why they are used in their newer applications. Here you will find interesting, informative items and illustrations showing the methods by which progressive engineers are taking advantage of the properties of materials—both new and old.



BIMETAL SAUCEPAN LID

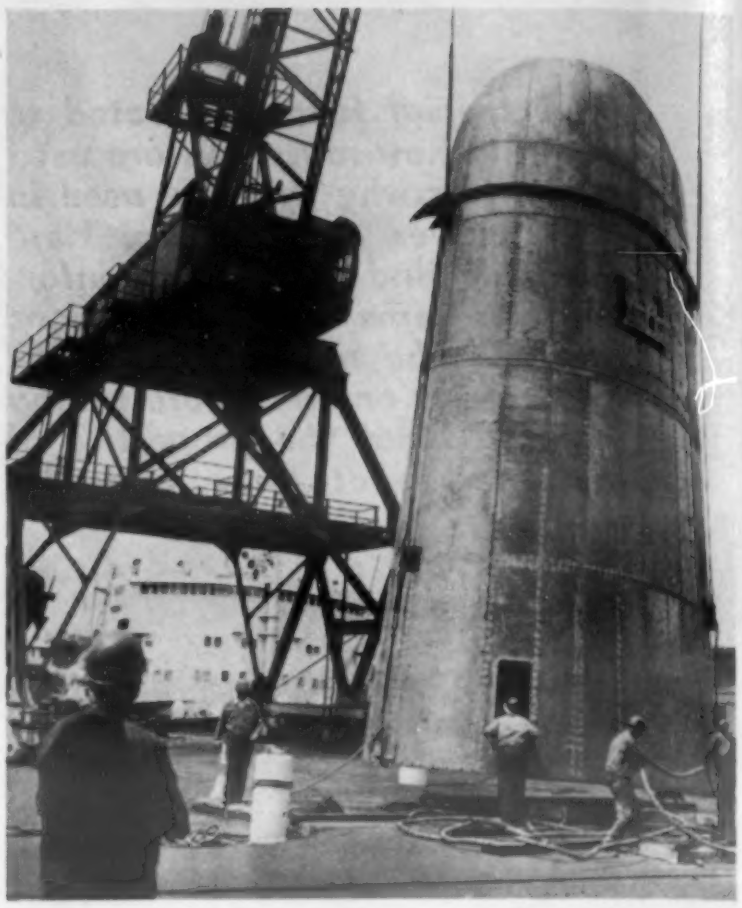


Invar and stainless steel are combined in a pressure cooker lid made by General Mills, Inc., to obtain a sealing action during cooking. The upper surface of the lid is 18:8 stainless steel bonded to a sheet of Invar. The latter metal has the lowest thermal expansion of any commercial metal up to 400 F. In use the cover fits loosely at first. As heat is applied, water is converted to steam, forcing air out of the pan. When steam contacts the bimetal cover and heats it, flexing the lid downward forcing a sealing ring tightly against the pan rim, a pressure-tight seal results. At cooking temperatures, Invar expands only about 1/13 as much as the stainless steel. Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.

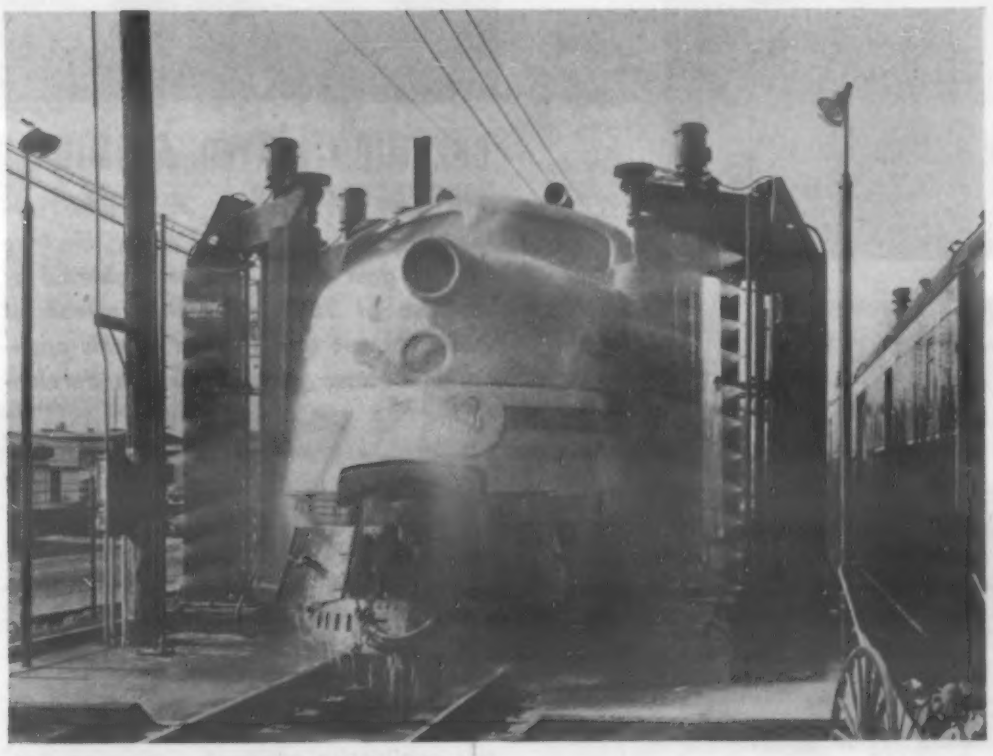


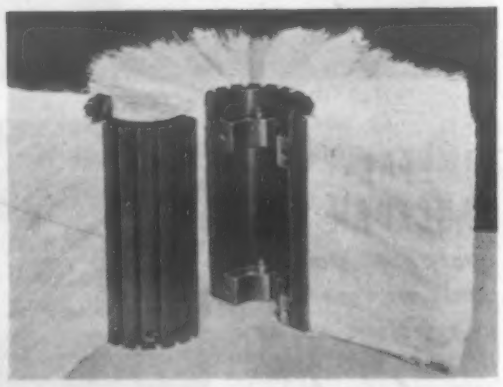
CHROMIUM-PLATED ALUMINUM AIRCRAFT PARTS

A weight saving of approximately 25% on airplane landing gear struts has been achieved by the use of 75ST aluminum instead of steel. The use of aluminum on this application became possible through development of a new process, making possible the bonding of chromium directly to aluminum. As produced for Chance Vought military planes by the Cleveland Pneumatic Tool Co., the oleo section of each aluminum landing leg is protected with 0.002 in. of chromium. The chromium is applied by Van der Horst Corp. of America. Relatively poor wear resistance of aluminum made impractical its use on this application previously. Wear or scoring of the strut within the oleo cylinder in cushioning landing shocks would permit leakage of hydraulic fluid. Plating of chromium on aluminum is accomplished without under plating of any kind. The plated surface is smooth and hard and is expected to have a longer life than steel in this application.

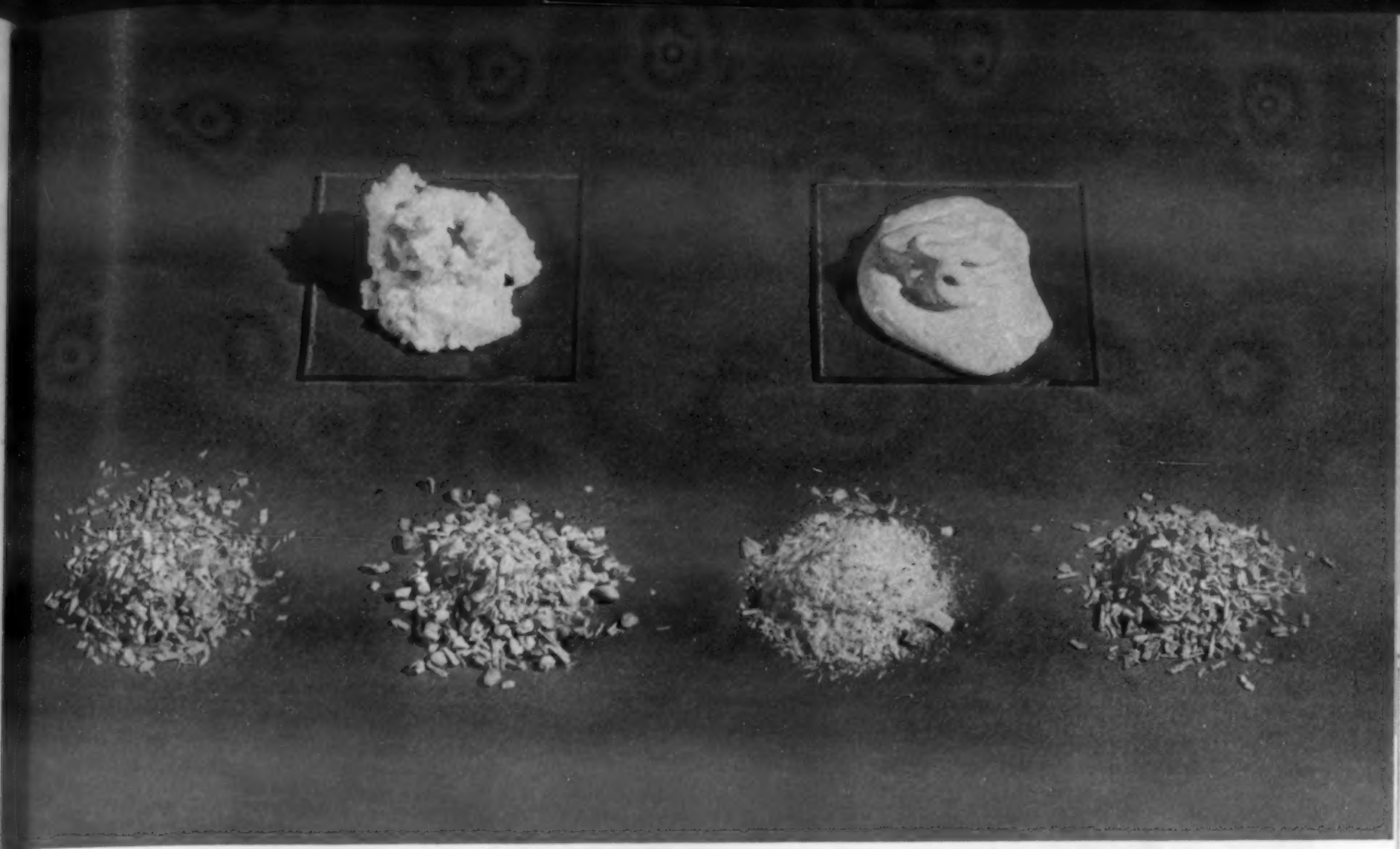


ALUMINUM SHIP STACKS *Being lifted into place here is a 9½-ton aluminum smokestack for the U. S. Corps of Engineers' dredge "Comber". The 39-ft. funnel is nearly twice as high as the black iron stack it replaced, but weighs the same. This is the first aluminum stack constructed in Todd Shipyards Corp. fabricating shops.*





PLASTIC BRUSH HOLDERS *Plastic brush holders have helped keep maintenance costs to a minimum on the mechanical railway car washer made by the Whiting Corp., Harvey, Ill. Originally, wooden cores with bristles fastened permanently in place were used. Now, a brush strip has been developed by Fuller Brush Co. which can be inserted into a groove. This makes possible a permanent core into which new bristle units can be fitted as old ones wear out. Because of the effect of water on wood, that material was not considered satisfactory. Likewise, metals which would stand up under the water and washing solution were either too heavy, too expensive, or both. Thus, a plastic was decided upon. The Durez brush holders are molded in two halves. Brass inserts are molded in and brass cap screws lock the core around a 2½-in. shaft. The plastic parts are molded by General American Transportation Corp., Plastics Div.*



These are samples of various cleaning and polishing materials and carriers for tumbling plastics.

Plastic Parts Are Cleaned and Finished by Tumbling

by **HAROLD A. KNIGHT**, News Editor, Materials & Methods

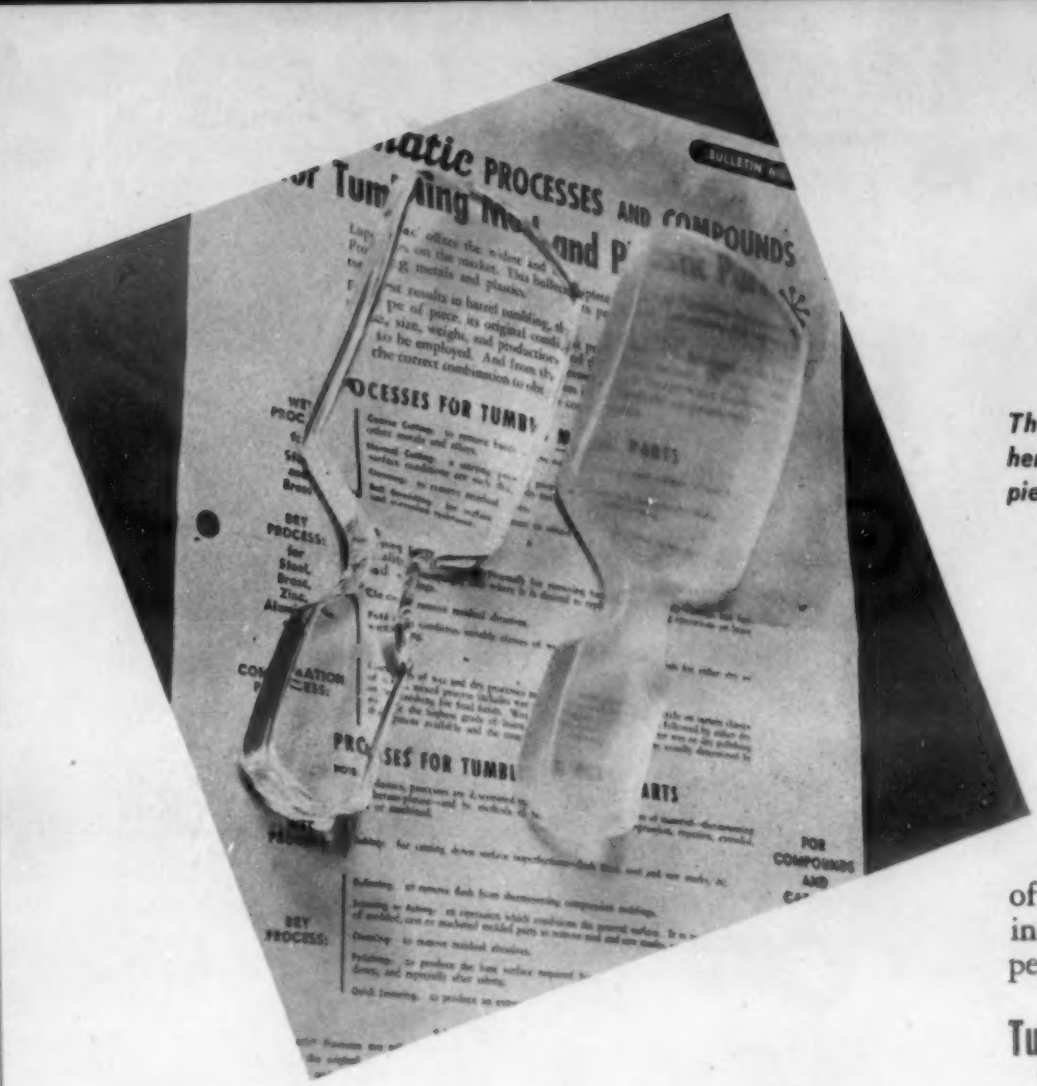
MANY TYPES OF PLASTICS—both thermosetting and thermoplastic—are being finished by barrel tumbling with lower costs and superior results than obtainable through buffing. Not all plastics nor all shapes and sizes of parts can be tumbled, but where applicable tumbling offers many tangible advantages.

Small, intricate plastics parts are cleaned and polished faster and more easily by means of barrel tumbling.

From a cost standpoint, tumbling is superior to buffing, in that large quantities of parts can be finished by tumbling with little or no attention after the cycle has been started. In buffing, of course, parts must be individually handled. Other instances where tumbling is superior to buffing—even at higher cost—are cases where buffing will not reach recesses, holes and undercuts, or where buffing might damage screw threads.

In principle, the tumbling of plastics is comparable to the finishing of metal parts by similar processes, although there are some variations in equipment and considerable differences in compounds used. The methods and equipment described here are known as the Tumb-L-Matic process, developed by Lupomatic Industries, Inc., New York.

The types of plastics most commonly tumbled are: thermoplastics—styrene, methyl methacrylates, ace-



The results of tumbling are sharply evident here in the two Lucite brush handles. The piece at the right has not been tumbled.

tates, acetate butyrates, ethyl cellulose and nitrates; thermosetting plastics—phenol formaldehydes, urea formaldehydes. Types of fabrication that fit into the tumbling picture are: casting, compression molding, injection molding, extrusion and machining.

The usual functions that tumbling performs for the various types of fabricated parts are: cast pieces —finishing and providing a high luster; compression molded—deflashing and finishing; machined—finishing; laminated—some types require finishing; injection molded—tumbled when a break-type die is used; extruded—usually need surface finishing, especially if individual parts have been sawed from a master part, leaving saw marks.

According to Lupomatic engineers, it is generally economical to tumble parts ranging from 1/16-in. dia., such as beads, to parts as large as a grapefruit. In sizes larger than indicated it is likely that hand buffing will be cheaper. On small, mass produced parts tumbling is usually done at a cost saving of at least 50% over buffing.

Tumbling time may vary from 7 to 30 hr., although most tumbling cycles range from 12 to 20 hr. for cutting down and smoothing operations.

Most common equipment for tumbling is the wet barrel, which is completely enclosed and watertight. For dry definning another type of barrel is used. The second type is an open meshed barrel, through the meshes of which burrs, fins and other unwanted material drops out. In using meshed barrels, the parts are often used as their own abrasive as they impinge upon each other. In other circumstances the action is furthered by balls and pegs. A third barrel of sheet steel and wood liner is used for dry finishing procedures.

Various types of abrasives, carriers and auxiliary compounds are used in tumbling plastics. Soft types of carriers are used on this class of work. The carriers include ivory chips, hard maple balls, maple shoe pegs, wooden spools, sawdust and similar materials.

Tumbling Procedures

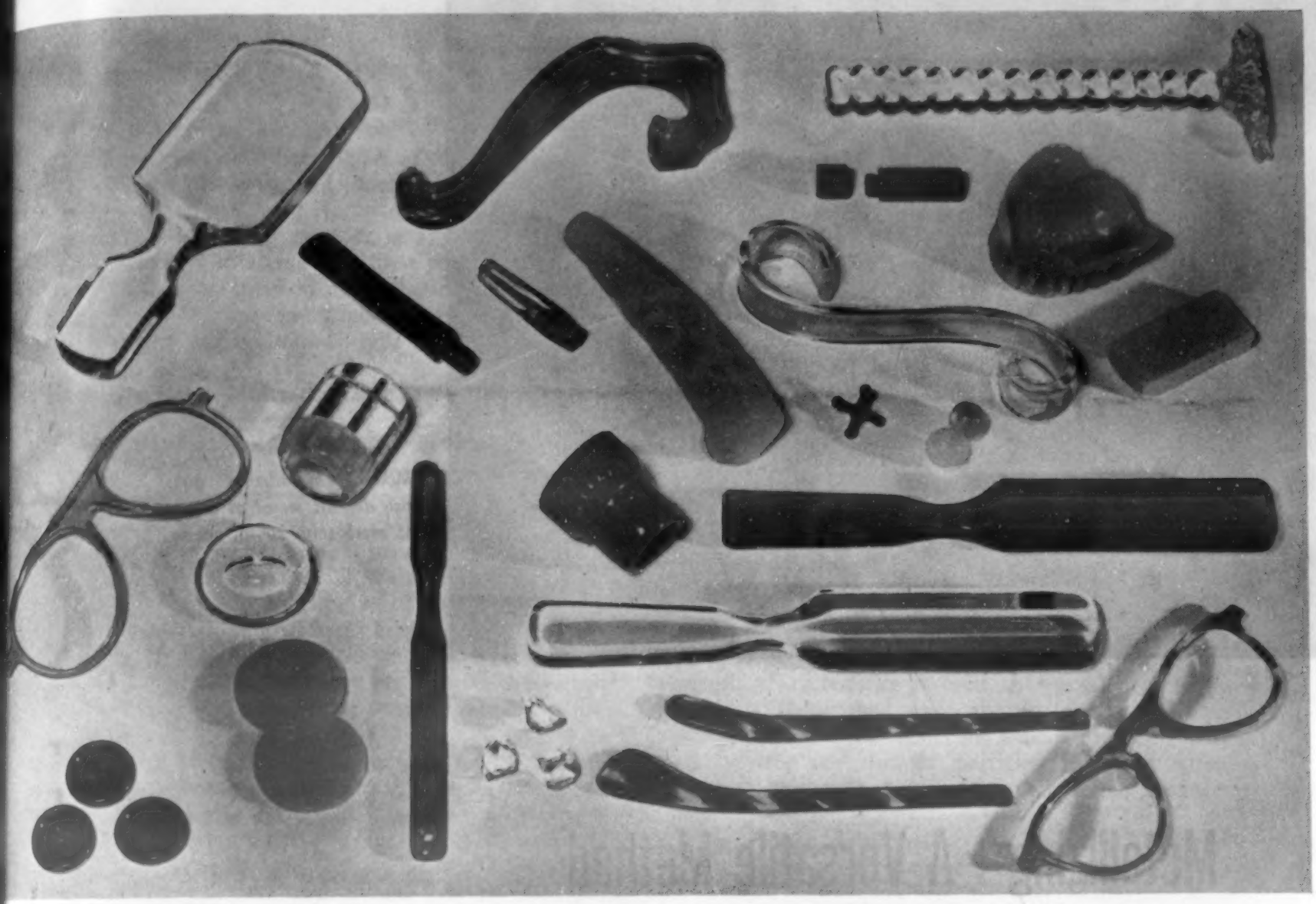
The three usual steps in tumbling are known as ashing, polishing and waxing. Sometimes one of these steps is omitted, depending upon the material being tumbled and the results desired. Ashing gets its name from early use of volcanic ash, or pumice. Waxing, though originally appropriate because wax was used, has recently become a misnomer because the plastic is now left in its natural state, with more pleasing results.

No general rules can be established for tumbling plastics. For best results each type of part should be studied to determine the steps required, compounds needed and necessary time cycles. Ashing can vary from 4 to 50 hr., depending upon the condition of parts. This step is most critical because in ashing considerable damage can be done if misapplied. Frequently wet ashing will be most effective. In such cases, a slurry of abrasive cream and water is used in a watertight barrel.

One of the newest developments in wet ashing consists of filling the tumbling barrel with chopped ice. The ice acts as a carrier and often stands up for as long as 8 hr. before it is completely melted. When ice is used, the tumbler barrel is left loose so the melted ice water can seep out. The ice method is especially well adapted to acetates, vinyls and acrylics. The ice method has reduced ashing time in some instances from between 4 and 5 days down to 8 to 24 hr.

The second step in tumbling plastics uses a polishing compound that is an extremely fine abrasive. This step corresponds to Tripoli buffing and is usually completed in 5 to 10 hr. Under certain conditions this step is eliminated.

The final step, waxing, is called "lustering" by Lupomatic since development of a method which does not require wax. In lustering a special compound is used, producing a finish which approaches that obtained through highly polished dies. The method leaves a true plastic surface finish with no wax film.



All of the plastics parts shown here have been finished by tumbling through methods developed by Lupomatic Industries, Inc.

Examples of Tumbled Work

With the vogue for massive spectacle frames of plastics, there is much interest in tumbling on the part of manufacturers. Plastic buttons also come out of the tumbling barrels beautifully, being ideal because they are small and thousands can be treated in one batch. In both instances hand buffing is difficult and costly, if not impossible.

One of the most striking examples is Lucite ornaments or beads. As they enter the tumbling process they are opaque, like a ground glass stopper in a bottle, but come out of the barrel transparent, glossy and smooth. In the case of typewriter keys, not only does the process improve the finish of the plastic, but removes excess filling materials. Among unusual applications of tumbling are the finishing of plastic false teeth and dentures.

Tumbling can handle irregular pieces and fragile ones, such as Christmas tree ornaments with walls only 1/10 in. thick. Tuning pegs on stringed musical instruments come out well. Novelty toys and beads are well adapted. Plastic handles for pots, pans, knives, brushes, etc. are most economically finished.

Special Considerations

The common tendency of the beginner is to crowd too many parts into the barrel at one time. Better to under-load and gradually increase until the maximum in results has been attained.

Again, cleanliness, so often preached in all enterprises involving materials engineering, is important here. Certain barrels should always be used for only one of the three common steps. Despite the most thorough cleaning, some abrasive is bound to remain adhering to the wooden lining, which contaminates the next operation where finer abrasives should be used.

It is important, too, to know what tumbling materials can be reclaimed after use—and how; and what must be discarded. One must know the best speed of barrel rotation and number of hours of tumbling, all varying with the particular job.

It is perhaps appropriate to mention a new technique developed in tumbling of soft rubber, somewhat related to cracked ice for soft plastics, mentioned previously. In the case of certain soft rubber molded parts, the flashing is taken off by freezing to as low as minus 100 F and tumbling them against one another until the embrittled fins break off. When the rubber parts return to room temperature they still have their normal characteristics. The art of tumbling has now progressed to the point where it is often impossible to tell the difference between tumbling and buffing.

Modern metallizing guns can deposit metal at a rate of more than 20 lb. per hr.

Metallizing—A Versatile Method for Production and Maintenance Work

by JOHN E. WAKEFIELD

THE PROCESS OF SPRAYING molten metal particles is reported to have been introduced into the United States from Europe as early as 1910. However, as a commercial process, metallizing dates from the early thirties when the basic patents expired. The first American company to manufacture "guns" in any quantities started in business in 1932. While the process is used fairly widely now for rebuilding worn mechanical parts, it has not gained as wide acceptance as it seems to deserve.

This is due, in all probability, to two factors. First, the manufacturers of metallizing guns seem to have devoted more time to the improvement of equipment than to process development. Secondly, industrial men have not had the time, in recent years, to investigate the process thoroughly. Undoubtedly, both these matters will be corrected as time goes on.

The fact remains that metallizing appears to offer much to industry, not only in maintenance but in production. It is logical that a process which can rebuild worn mechanical parts, and often improve them as well, should have a place in production methods. The great strides which have been made in metallizing equipment itself promise well for the future.

The 1932 "guns" would spray about 1½ lb. of steel per hr., provided they could be operated that long continuously. The latest production metallizing unit deposits over 20 lb. per hr. In sixteen years, then, the rate of deposition has increased from a point below that of welding to many times the average welding speed. That in itself seems significant enough to arouse the curiosity of maintenance men and design engineers alike.

A proper balancing of advantages and limitations will show that metallizing can be used in many ways.

As far as the process itself is concerned, some manufacturers have been inclined to regard it as almost a cure-all. It isn't, of course. On the other hand, many industrial men have investigated it solely for jobs which could not be done in any other way. Because it failed to accomplish their particular purpose, they have been inclined to condemn it as worthless. The scientific approach, which carefully weighs both advantages and limitations, will discover metallizing between these two extremes.

One advantage of metallizing appears to be its low cost. Rebuilding worn shafts and cylindrical shapes often amounts to as little as 10% of replacement cost. Another advantage is its low heat. The base material is seldom raised to a temperature in excess of 250 F, and often the heat can be kept below 150 F. Compare that to arc-welding, where fusing temperatures are required in the base as well as the electrode. Another favorable point is the ability of coatings to absorb oil and run with low friction. Perhaps the greatest advantage is the versatility of the process. Any metal available in wire form can be sprayed successfully. Any one of them can be applied to almost any base material.

On the other side of the picture, the two greatest limitations are low tensile strength and ductility, and a comparatively low bond strength. These factors certainly prevent the use of metallizing in some kinds of work. Threads, gear teeth and bearing races are not at all practical and should not be attempted. Surfaces subjected to sharp impact, such as cams and dies, are similarly impossible spots for metallizing. However, once these limitations are known and clearly understood, one is free to consider the great mass of work for which metallizing is safe and economically feasible.

Perhaps a brief résumé of metallizing, as it stands in 1948, will indicate possibilities that are not yet realized on a wide scale.

Preparation of Surfaces—Logically, a study of metallizing begins with the condition and preparation of surfaces to receive the sprayed coating. Materials of a rough or open surface generally need no preparation. Wood, paper, plastic, cloth and fibrous materials fall into this category. Of course, the higher melting point metals tend to burn them. Therefore, a coating of zinc, aluminum or lead is generally used as an undercoat. These low melting point metals bond very readily to all of the above materials. The only requirement is that they are clean and free of oil, moisture or other foreign matter.

Plastics and some other nonmetallics can be prepared, usually by blasting with sharp clean sand or similar blast abrasives. Here again, in most instances, an undercoating of low melting point metal should be used. Glass is most often prepared simply by heating to about 500 F. Thus, a fusion bond is accomplished. The only real problem is the sudden chill of the glass by the metallizing air stream. Considerable work of this kind is being done successfully, however.

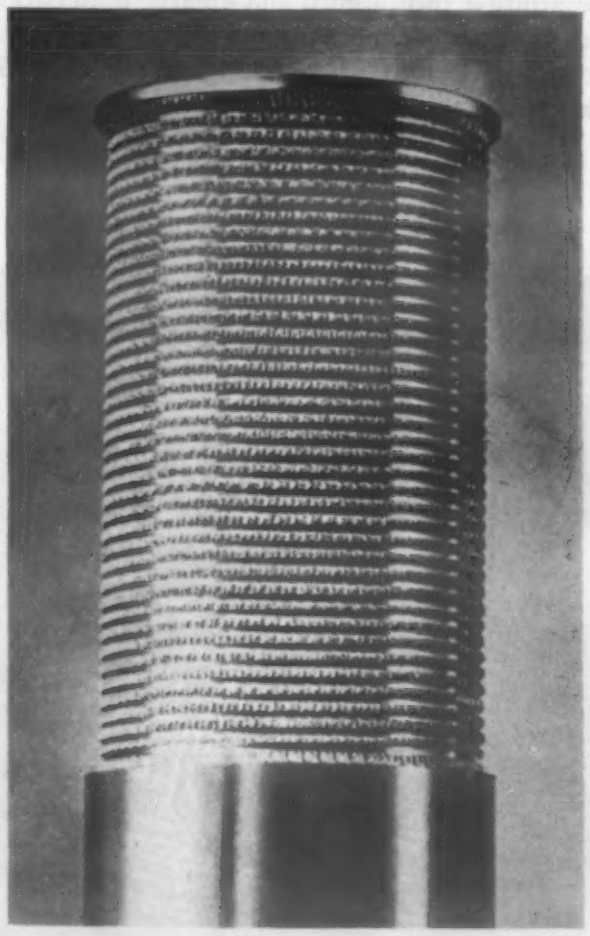
Metallic surfaces must be cleaned thoroughly and usually roughened as well. This cannot be too highly emphasized. Most of the metallizing failures which have occurred can be traced directly to careless preparations or lack of understanding of it. Anyone who has wielded a paint brush, soldering iron or welding torch should understand the necessity of thorough cleaning. The roughening is not so clearly understood.

Several methods have been devised which clean and roughen metallic bases simultaneously. On shaft work, for example, a tearing thread cut will expose bright metal and produce a rough surface at the same time. This method of preparation is limited, however, since it tends to leave fracture lines in the base.

One successful method, which is generally much safer than rough threading, is the use of round bottom threads. The lands between are roughened by a sort of knurling tool. This not only cuts up the lands irregularly but rolls thin edges to produce dovetails in each groove.

Some metallic bases, of course, are too hard to be machined. Here, an electrical method is available. Equipment similar to an arc welder but with different current characteristics is used. A special nickel-type electrode is brushed over the surface. It deposits broken bubbles of material which provide many anchors for the sprayed particles. Even on softer materials this method over a 24 pitch thread produces a strong bond.

The newest development, and one which appears quite revolutionary, is the use of a metal wire which



Most surfaces, to be metallized, must first be roughened. This surface was prepared by tools which combined round-bottom threading and knurling.

bonds itself to the base. With this material, thorough cleaning of the surface is all that is necessary in many cases. It will bond strongly even to highly polished surfaces. It changes the whole aspect of metallizing, in that preparation of many surfaces can now be done with the spray gun itself.

Even with this new material, however, it is recommended that a shaft be rough turned. Not a thread or groove as before, but the ordinary roughening cut which is commonly used in preliminary machining operations. For one thing, it is certainly one of the quickest ways to clean a surface that has been in operation. Secondly, rough turning greatly increases the bonding area.

All of these methods produce a good bond and undoubtedly all are needed in certain circumstances. It is significant that all clean the metal base, and all roughen it to provide mechanical anchors for the coating. Failures of metallized coatings do not occur where full knowledge of these facts exist. Certainly, all of these methods are a tremendous advance from the early thirties. In those days, blasting with sand or steel grit was practically the only method known.

The use of the metal wire which bonds itself to the base appears to be the most important step in metallizing progress to date. Much of the bond is actual fusion to the base.

The method has one limitation worthy of consideration. The material will not bond to copper or copper alloys. Even these metals, however, can be readily applied over it. But, enough of preparation, except to stress once again its major importance. It should be studied thoroughly and clearly understood. Allowance for an adequate method of preparation should be made in design of parts. It is the most important factor in metallizing.

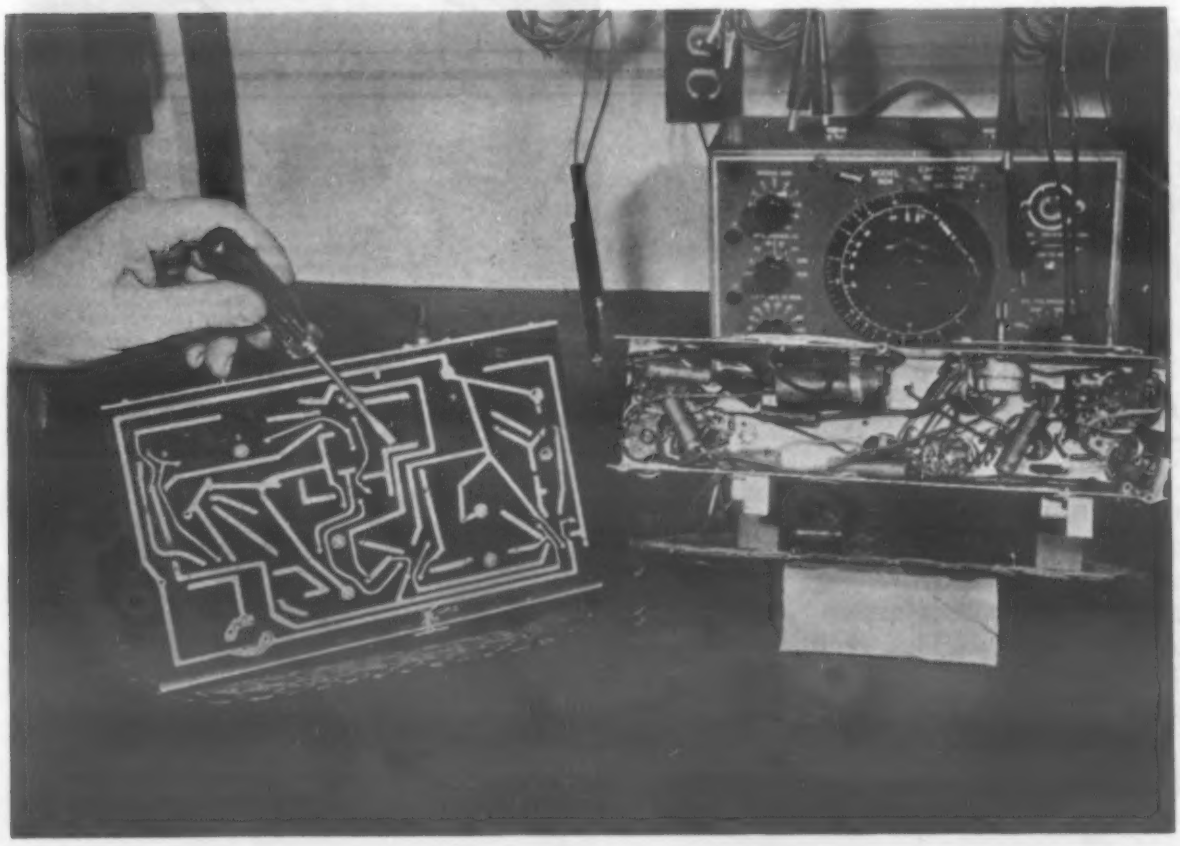
The Bond—When the molten globules or spheroids leave the metallizing gun, they strike with considerable force. Their heat and the force together cause them to flatten out, almost to spatter, on the work. It was believed some years ago that they keyed themselves into the hooks and tears left by the roughening of the base. A study of photomicrographs indicates that this is only partly true. What actually holds them there, as of 1948, appears to be a combination of three factors. Mechanical keying certainly exists to some extent. Molecular attraction is evident as well.

The third consideration has been brought forward much more recently and is apparently quite sound. Each spheroid is covered, from the time it leaves the gun, with a thin film of oxide. When the particle flattens, the surface area is greatly increased and the oxide film ruptured, exposing pure metal again. This bonds to the oxide in the base. It is well known that metals and thin oxide adhere to each other tenaciously. Then there is what might be called "oxide cementation" of the original particles to the base material.

Since all three factors clearly exist, it is quite reasonable to believe that the bond between base and sprayed metal coating is a combination of them all.

Coating Structure—Similarly, the particles within the coating itself bond to each other as the coating builds up. A thin film of oxide forms on each particle again as soon as it flattens. Other particles strike, flatten out, rupture thin film, and bond thin metal to the oxide of the previous particles.

The structure of metallized coatings, thus, consists of metal particles, oxides and voids. What does this mean in terms of physical properties?



One method of making "printed" electrical circuits is by spraying through a stencil.

Physical Properties of Sprayed Metals

Metal	Specific Gravity	Percent of Original Wire	Ultimate Strength, Psi.	Increase in Length	Rockwell Hardness
Aluminum	2.408	94.1	19,500	0.23	H-72
Babbitt (High Tin)	6.671	86.6	—	—	H-58
Babbitt (Lead)	6.653	86.4	—	—	H-11
Brass (Yellow)	7.442	88.3	—	—	F-85
Bronze (Commercial)	7.574	86.6	—	—	F-68
Bronze (Phosphor)	7.676	86.5	18,000	0.35	F-75
Bronze (Tobin)	7.461	89.2	13,000	0.51	F-78
Copper	7.535	84.4	—	—	F-78
Monel	7.671	86.5	—	—	F-78
Nickel	7.551	85.8	—	—	F-87
Stainless (18:8)	6.934	88.9	30,000	0.27	B-79
Stainless (Cr.-Carbon)	6.742	88.7	40,000	0.50	C-32
Steel (0.10 Carbon)	6.673	86.7	30,000	0.30	B-90
Steel (0.80 Carbon)	6.356	82.5	27,500	0.42	C-38
Tin	6.426	88.1	—	—	H-10
Zinc	6.363	89.0	13,000	1.43	H-46

Physical Properties

Clearly one property of a sprayed metal coating is that it is porous. At first glance, this appears a distinct disadvantage. In corrosion protection, it is, for it limits metallizing to those materials anodic to the base. Zinc and aluminum are high in the electro chemical series, and do protect iron and steel effectively, in spite of slight porosity. Other metals will protect only where the coating can be physically sealed. It is possible to seal tin and lead coatings by shot blasting. This peens the coating and effectively closes the pores.

Porosity is a definite advantage in surfaces that are lubricated. It has been found that metallized materials absorb oil and maintain an excellent film. They move with appreciably less friction than the same materials in other forms. The explanation is logical. Oil absorption, together with the fact that there is actually less surface area in a porous material, accounts for this feature.

Other properties which tend to limit use of the process are low ductility and relatively low tensile strength. However, it should be pointed out that tensile strengths are generally much higher than was supposed in earlier days.

One property which deserves especial mention is the hardness of metallized metals. It will be observed that hardness readings in the Rockwell scales are fairly low. However, the wear resistance of sprayed steels, stainless steels and the like is out of all proportion to the hardness readings. This is undoubtedly due to the fact that particle hardness is much greater than that of the whole mass. For example, sprayed 0.10% carbon steel frequently outlasts 0.10% carbon shaft stock.

Most methods of hardness testing actually measure elasticity, tensile strength and penetration much more than particle hardness. They are, for that reason, quite undependable for metallizing standards. Metallizing is more like some of the hard-surfacing materials which consist of very hard particles bonded in softer masses.

Much more space could be devoted to physical properties of sprayed materials. It is important to realize that most common materials standards are not adequate for an understanding of the coatings. They are quite different from other materials and should therefore be approached in an entirely different manner. When this is done by industrial men, the process will gain considerably in interest and value.

Metallizing Equipment—There may be some who are not familiar with the equipment which does this interesting work. There are three general types of "guns." One is the so-called "pot-type." In this, the metal is melted by electrical means or gas-oxygen flame in a sort of crucible. In some the molten metal drips into an air stream which atomizes and sprays it. In others, the air stream passes over the molten mass, picking up particles and blowing them onto the work. Generally such units are limited to metals with melting points below 600 F. They have been and are used quite extensively for filling dents in fenders and bus body panels.

Another type uses metal in powdered form. One such unit feeds the material by a sort of Venturi into the flames, which melts it and sprays it. In another unit the powder is forced by air pressure into and through the flame. Both "powder type" guns will operate quite successfully on zinc, but are limited to relatively low melting points.

Aircraft cylinder head assemblies are aluminum-coated at a rate of one every 55 sec. by metallizing.

By far the most widely used type of metallizing gun today is the "wire-type." In this a feeding mechanism activated by a compressed air turbine forces the wire into the center of a more or less circular oxy-gas flame, most commonly oxyacetylene. Other oxy-gen-gas combinations can be used, however. Guns of this type are most efficient and will handle metals with melting points even about 3000 F. Thus, any metal available in wire form from soft solder to high chromium-carbon stainless steels can be sprayed readily.

One point of note. The actual shearing of molten metal off the wire end is accomplished by the hot gasses rather than air. Hence, oxide inclusions are not as great in the coatings as might be believed. Further, it has already been pointed out that a certain amount of oxide is advantageous in the bonding of particles to the base and to each other.

Metallizing Applications

The use of sprayed metal coatings fall into five categories of major importance:

Mechanical—The field in which metallizing is most widely used at present is that of mechanical applications. The rebuilding of worn areas has saved many thousands of dollars in maintenance and salvage operations. Modern guns, which spray 20 lb. of steel an hr., cut repair time and save hours of otherwise lost production.

To a limited extent, mechanical parts have been metallized in production. The process seems to have definite possibilities here. Take a turbine shaft, for example. Only a few inches of its length in packing or stuffing area are subject to special conditions such as corrosion. Producing such a part of easily machinable steel and metallizing and critical areas with stainless is highly practical. Machine time and material cost are reduced substantially, but protection is afforded where it is needed.

Similarly, parts of a shaft where good lubrication is of major importance can be treated with a sprayed coating. Again, the sections where critical conditions exist are given a superior surface on an otherwise inferior base material.

Corrosion Protection—A second field is that of corrosion protection. A group of butane holders metallized with zinc on the area exposed to salt, and industrial atmospheres received a coating only 0.003-in. thick when metallized in 1936. Inspected in 1947, they showed spot corrosion on 5% of their surface. These spots were cleaned and remetallized and an additional 0.003-in. of zinc was applied over the upper half of the tanks. The gas company which owns them anticipates 25 to 30 years protection from the present 0.006-in. zinc coating. This estimate is based on their experience with metallizing over some 16 years.

It has been indicated above that metallizing is limited to those coatings that are anodic to the base, or cathodic coatings which can be sealed. Zinc, aluminum, tin and lead will stand up in many varied conditions encountered in industry. Metallizing is well worth consideration in many corrosive conditions.

Hard-Surfacing—Recently a wire has been developed for hard-surfacing by metallizing. The material itself consists of hard powdered metal extended in a plastic binder to form a wire. The plastic completely volatilizes in the spraying operation, leaving metal alone on the base. After spraying, the material is heat treated or fused with a torch or heating nozzle. Thus, it is securely bonded and homogeneous.

The advantages of applying hard-surfacing material by metallizing are several. First, a really uniform coat can be applied. Secondly, less material is needed because of its uniformity. Thirdly, there is less finishing to be done. Finally, rate of deposition is considerably faster than by other methods.

Electrical—There appear to be many practical possibilities in the electrical field. Conductivity of sprayed metals is only slightly less than common types of metals. Resistance is usually somewhat higher. Thus, it offers many advantages. Carbon resistors, carbon brushes and other carbon parts are metallized with copper for electrical contact, as for soldering operations. Silver can be sprayed on bus bars and other parts. Circuits are being sprayed on glass and other materials. Porcelain and other products are sprayed successfully.

Production—The word production covers a wide field. Actually, many of the jobs noted under the electrical category are production jobs. They are handled by conveyor or semi-automatic systems, with the metallizing gun mounted in a fixed position. During the war, aluminum coating of aircraft cylinder head assemblies was speeded from one every 8 min. to one every 55 sec. Small parts, such as speed nuts, have been sprayed with zinc in tumbling barrels. There is truly a tremendous variety of possibilities for metallizing in production work on metal glass, porcelain, plastic, wood, cloth, paper and other bases.

ATERIALS & METHODS MANUAL

This is another in a series of Manuals on engineering materials and their processing published as special sections in Materials & Methods. Each manual is complete in itself and is intended to serve as a reference book on the subject covered. These manuals provide the reader with useful data on characteristics of materials or fabricated parts, and on their processing and application. Preceding manuals have taken their places in the permanent reference files of thousands of readers.

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Selection and Application of Plastics

by Bernard Mack, Head, Chemical Engineering Dept.
Sam Tour & Co., Inc.

Plastic materials are available with almost any desired characteristic or group of characteristics. Thus, the selection problem becomes one of finding that material which has the ideal set of properties from the standpoint of intended service, methods of forming or fabricating, and ultimate cost. This manual presents comprehensive tables, together with explanations of what the various characteristics mean, to assist in the intelligent selection and application of plastics.

Contents

September 1948

Materials & Methods

These large plastic parts, including one weighing 650 lb., were produced by General Electric to be used as components of an atom smasher.

Introduction

This manual is intended as a sequel to "Materials & Methods Manual," No. 25—A Plastics Primer for Engineers, by Kenneth Rose—which was published in April, 1947, and is more specific with regards to the properties and applications of the various plastics. Consequently, much of the interesting and valuable background information, trade name listings, etc., given in the previous manual will not be reproduced. For this reason it is strongly recommended that the manuals be used in conjunction.

There is at present a strong feeling in the plastics industry, and this includes manufacturers of raw plastics as well as fabricators, that all plastic consumer products be thoroughly tested under actual use conditions and judged satisfactory prior to marketing. By the same token the buyer of plastic parts should be educated to the differences that exist between the various plastics and the necessity to perform use tests both for his own and his ultimate consumer's protection. It is unfortunate that most buyers and consumers are not aware of the numerous different types of plastics that go into consumer products and why different plastics are used. All such materials are classified under the general heading of "Plastics." Consequently, when an article or part made of a plastic fails under normal service conditions, the wrath of the user is directed not only to the direct supplier but to the plastics industry as a whole. There is very rarely the question of improper design or fabrication—it is just that "plastic is no good."

The Society of the Plastics Industry and the Plastics Materials Manufacturers' Association, as well as many individual manufacturers and fabricators, have pointed their advertisements and literature to the buyers and consumers of plastics products in order to educate these groups to the differences that exist between the various types of plastics. It is hoped that this manual will serve both these relatively non-technical groups as well as the personnel responsible for plastic product design and fabrication.

Selection of Plastics

The selection or specification of a particular type of plastic depends upon a varying number of factors classifiable under the following headings in relative order of importance:

1. Utility
2. Design
3. Appearance
4. Cost

Utility takes into consideration properties the plastic must possess in order that the product give good service for a reasonable time. As an example, for a toy automobile the plastic must be tough to withstand the variety of physical tests that only a child's mind can conjure. It must be non-toxic and not affected by occasional washings or short period immersions (possibly when used as a submarine). On the other hand, a sink strainer should be moderately tough but must be dimensionally stable on a long exposure to water, soap, and the many different types of oils and chemicals present in foods. In addition, it should maintain this dimensional stability when in contact with these substances for moderately long periods at temperatures of 140 to 160 F, which is the normal hot water range for household washing. In this instance it would be an added advantage, from a sales angle primarily, to use a plastic that can be sterilized and that possesses the other required attributes of toughness and chemical resistance.

The selection of a plastic from the standpoint of utility should be the first law of materials engineers, designers and fabricators who are responsible for the choice. Where such characteristics as cost and appearance are placed before utility, the results are usually a disappointment to all concerned.

The factors utility, design, appearance and cost, are not independent of each other. All must be given consideration in the evaluation of a plastic. Thus, if tetrafluorethylene plastics (Teflon), were commercially available in the form of molding powders, this plastic which is inert to all chemicals would not be universally used for sink strainers and the like unless the cost was materially reduced from the present 13 to 15 dollars per lb. By the same token, design considerations may make it necessary to select plastic "A" over plastic "B" al-

Table I—Types and Forms of Plastics

Resin Type	Class	Forms Available	Methods of Fabrication or Use	Outstanding Properties	Representative Applications
Acrylic Resins	TP	Molding powders, liquid resins, solutions, emulsions, standard sheets and shapes, films	Injection molding, compression molding, extrusion molding, casting, coating, forming, machining	Edge lighting, weather resistance, optical clarity	Windows, instruments, dentures, plating barrels, finishes, models, display signs, toilet articles, furniture, lamp bases
Alkyd Resins	TP	Air-drying resins, solutions, emulsions; nondrying resins, solutions; high melting pt., hard resins, modified types	Coating by all methods	Quick drying, film permanence and toughness, versatility of formulations	Emulsion paints, bacteria inhibiting wrappings, finishes for metals, enamels, inks
Allyl Resins	TS	Liquid resin, standard cast shapes	Casting, impregnation, laminating, postforming of cast sheets and laminates	Transparency, surface hardness	Embedding of delicate objects for display and preservative purposes. Jewelry, goggle lenses, decorative containers, place mats
Aniline-Formaldehyde Resins	TS TP (ltd.)	Molding powder, varnish, standard forms and shapes	Compression molding, injection molding (rarely), impregnation, forming, machining	Good insulation, low loss and high dielectric strength over wide frequency range, maintenance of electrical properties on weathering	Electrical parts for ultra high frequencies or when exposed outdoors, antenna housings, etc.
Benzyl Cellulose	TP	Experimental quant. molding compounds, films, lacquers	Compression molding, injection molding, extrusion molding, lacquer coating	Low moisture absorption, high arc resistance	Possibilities: hot melt coating, electrical insulation
Cashew Resins	TS	Powders and granules, liquid resin	Casting, coating, impregnation	Alkali resistance, cold setting, solubility in petroleum solvents	Cold set cements, impregnation of porous materials, potting of electrical and radio assemblies, protective coatings, adhesives
Casein Plastics	TP (ltd.) TS	Casein powder, sheets, rods, tubes, disks, forms, etc.	Molding (limited), machining, punching, pressing	Colorability, ease of machining and polishing, resistance to drycleaning solutions, nonflammability	Buttons, buckles, beads, handles, frames, novelties, radio parts
Cast Phenolics	TS TP (ltd.)	Liquid resin, cast sheets and standard shapes, custom-made castings	Casting, postforming of sheets, machining, embossing	Appearance, water resistance, non-electrostatic	Desk accessories, home furnishings, covers for electrical instruments, radio housings, cutlery handles, umbrella handles
Casting Resins	*	Liquids, semi-solids	Casting	Formability in molds, no pressure (no heat with some) required for cure. Other properties vary with resin type formulation	Models, small run novelties, short run metalworking dies, jigs, foundry patterns
Cellophane (Regenerated Cellulose)	TP	Sheets, films, foils	As such or laminated, sealed	Depends on treatment, low cost, grease resistance, moisture proof	Wrapping, decorative trim, envelopes, straws, packing
Cellulose Acetate	TP	Molding compounds, coating compositions, casting compositions, standard sheets, films, foils and shapes	Injection, compression and extrusion molding, calendering, casting, forming, machining	Versatility in formability and colorability, mechanical strength, toughness, resistance to cleaning fluids	General household utility items, machine and operator shields, buttons, closures, novelties, toys, models, drafting instruments, belting, washers, small hand motor housings, handles, electrical insulation, tooth brushes, tuck combs
Cellulose Acetate Butyrate	TP	Molding compounds, casting resin, coating compositions, solvent, gel, and hot melt, standard sheets and forms	As for Cell. Acetate plus-dip coating, impregnation	Dimensional stability over range of moisture and temp. (not sterilizable), toughness, may have odor	Strippable coatings, telephone housing, irrigation tubing, steering wheels, photographic film spools, toilet seats, paper and fabric coating (applications also as for Cell. Acetate)

* Not a specific type. See Acrylics, Allyl, Ethyl Cellulose, Phenolics and Styrene, Unsat. Polyesters, Cellulosics, etc.

Table I—Types and Forms of Plastics (continued)

Resin Type	Class	Forms Available	Methods of Fabrication or Use	Outstanding Properties	Representative Applications
Cellulose Acetate Propionate	TP	Molding compounds, standard sheets, films, forms	As for Cellulose Acetate except limited in casting	Dimensional stability and shock resistance over range of temp. and humidity; molding to closer tolerances than cell. propionate	Fountain pens, pencils, telephone housings, optical frames, appliance housings, toilet seats
Cellulose Nitrate	TP	Standard sheets, shapes, forms, films, foils, lacquers, emulsions, colored chips	Calendering, extrusion molding, blow molding, forming, machining	Toughness, ease of fabrication, flammable, low moisture absorption	Blown objects, balls, dolls, rattles, optical frames, fountain pens and pencils, drawing instruments, mallet heads, handles, frames, eyelets, toilet seats, containers, billiard balls
Cellulose Propionate	TP	Same as for Cell. Acetate Propionate	Same as for Cell. Acetate Propionate	Dimensional stability and shock resistance over wide range of temp. and humidity	Same as Cell. Acetate Propionate
Cold Molding Compounds	TS	Asphaltic binder; molding powder, asbestos filled Phenolic binder: as above Cement binder: as above	Compression molding	Low cost, ease of molding, non-burning, electric arc resistance As above with higher cost, higher str., better surface. Temp. resistant to 1000 F best arc resistance	Handles, knobs, parts used in contact with flame or at high temperatures. Electrical switch bases, plugs, sockets, etc.
Coumarone Indene Resins	TP	High melting powders, liquid resins, water soluble emulsions	Coating compounding	Excellent water and chemical resistance, wide compatability range	Protective coatings, floor tile, adhesives, paints, varnishes, inks
Ethyl Cellulose	TP	Molding compounds, standard sheets, films, foils, strip. Compounded formulations for hot melt coatings, lacquer base formulations	Injection molding, compression molding, extrusion molding, hot melt coating, lacquer coating, machining, forming	High impact strength and dimensional stability from −80 F to 180 F. Low density	Refrigerator parts, strippable coatings, flashlight cases, hose fittings, toilet seats, cable clips, clothes pins, containers, golf club heads, ice buckets, tool handles, bowling pins
Furane Resins	TS	Liquid resin — 100% or thinned	Impregnation, adhesive, coating, casting	High bond strength, high temp. resistance and chemical resistance	Adhesive (particularly for phenolics) impregnant for porous materials, cast articles for chemical resistant use
Lignin Resins	TS TP	Laminating paper, molding compositions, filler compositions, pulp, liquid resins, pressed sheets	Laminating, vacuum preforming, compression molding, coating, machining	Low cost	Wallboard, electrical insulation, coated table tops, flooring, toys, boxes, extender for phenolics
Melamine Resins	TS	Molding powders (with various fillers), powdered resin, resin solutions	Compression molding, impregnation, coatings, adhesives	High arc resistance, transparency and colorability (plus those listed for phenolics)	Tableware, kitchenware, electrical instrument parts and housings, paper impregnation, buttons, adhesives
Methyl Cellulose	TP	Liquid resins, solutions of varying viscosities	Coating	Grease and wax resistance, film toughness, water solubility	Grease repellent wrapping, water emulsion paints, mold coating
Phenol-Furfural Resins	TS	Molding compounds, cements, liquid resins and varnishes, dry resin compounds	Transfer molding, low pressure molding, injection molding, cold molding, impregnation, coating	Quick curing, low temp. flow on molding, non-scorching at high temp. (also those for Phen.-Form.)	Same as for Phenol-Formaldehyde. (See below)
Phenol-Formaldehyde Resins	TS	Molding powders (different fillers) filled and laminated sheets and shapes, impregnated sheets, casting resins, varnishes	Compression molding, extrusion (limited), transfer molding, postforming, laminating, coating, impregnation, casting, machining	Heat resistance, dielectric strength, surface hardness, high strength	Housings for equipment, electrical insulators, gears, bushings, buttons, knobs, handles, structural parts in large sizes —pontoons, boat parts, etc., protective coatings, impregnation of porous materials

Resin Type	Class	Forms Available	Methods of Fabrication or Use	Outstanding Properties	Representative Applications
Polyamides (Nylon)	TP	Molding compounds, filaments, fabrics, ropes, standard strip, rod tubes	Injection molding, extrusion molding, forming, machining	High shatter resistance, retention of physical properties at high temp., sterilizable grades, chemical resistance	Wiring insulation, bearings, washers, tubing, for hot oils, slide fasteners, tableware, upholstery, fabrics, bristles, coatings
Polyethylene	TP	Molding compounds, spray powders, standard sheets and shapes	Compression molding, extrusion molding, injection molding, blow molding, drawing, flame spraying, machining	Electrical properties, moisture and chemical resistance, low density	Packaging, electrical wire insulation, high frequency insulation and parts, hose and lining in chemical industry, electrical plugs and outlets, bottle closures, wrist watch straps, washers, gaskets, ice cube trays, bowls and tumblers
Polyterpene Hydrocarbon Resins	TP	Powders, solvent solutions	Coating	Chemical and water resistance, compatability	Protective coating, compounding, paper coating, curing agent for cement
Resorcinol-Formaldehyde Resins	TS	Lump solids (with or without setting agent), resin solutions	Impregnation, adhesive, casting	Water resistance, low curing temp., affinity for wood	Wood ship keels, plywood tubing, wood furniture
Shellac	TP	Slabs and flakes solutions	Compression molding, injection molding, coating	Electrical insulator properties, carbonization resistance, high scratch resistance, ease of molding	Electrical insulation, phonograph records, inks, belt dressing, cable insulation, cloth, paper binder, wood varnishes, adhesives
Silicon Polymers (Silicones)	TS	Solid resin, greases, oils, varnishes, standard strip and sheeting	Coating, impregnation, laminating	Excell. electrical insulation at high temp., chemical and water resistance	Cable and electrical insulation —high temp., lubricants, cements, paints, laminated insulator boards, damping fluids, high temp. baths, water-repellent coatings
Sodium Carboxy-Methyl Cellulose	TP	Powder, water solutions	Coating, emulsifier, binder	Water solubility, grease and fat resistance	Grease proofing paper, emulsifier for lotions, leather binding
Styrene Polymers and Copolymers	TP TS (ltd.)	Molding powders, cast sheets, film, liquid resins, emulsions, solutions	Injection molding, compression molding, extrusion molding, casting, coating, impregnation	Low moisture absorption, low cost, excell. electrical prop., sharp fracture	Radio parts, electrical insulation and parts, bottle closures, combs, toys (selected), edge lighting displays, dishes, bowls, bottles, jars, battery cases, wall tile, buttons
Tetrafluoroethylene (Teflon)	TP	Standard sheets, rods, tubes, tapes, moldings, experimental quantities of molding powders	Machining, punching, injection molding, extrusion molding	Extreme chemical inertness, heat resistance, high cost	Valve packing and diaphragms, gaskets, heating plate covers
Unsaturated Polyesters	TS	Liquid resin, semi-solids, standard shapes	Impregnation, post-forming of laminates, casting, low pressure molding	Depends on type. See Casting Resins	See Casting Resins
Urea Resins	TS	Molding powders, (Alpha Cellulose base)	Compression molding, adhesive or binder	Similar to Phenol-Formaldehyde, plus colorability, light diffusivity	Decorative housings, buttons, tableware, paper treatment, adhesive, core binders
Vinsol Resin	TP	Flake, lump, powder emulsion	Impregnation, coating, compounding	Low cost, compatability, electrical insulation	Protective coatings, electrical insulator, lacquers, varnishes, adhesives, shellac extender
Vinyl Acetal	TP	Molding compounds, liquid resin, solvent solutions, standard sheets and shapes	Compression molding, injection molding, extrusion molding, coating	Low cold flow, surface toughness and hardness	Phonograph records, coating safety glass core, photographic film base, adhesive
Vinyl Acetate	TP	Powder, solutions, water emulsions	Injection molding, compression molding, coating solvent and hot melt	Good adhesive properties	Adhesives, coatings, lacquers, some moldings

Resin Type	Class	Forms Available	Methods of Fabrication or Use	Outstanding Properties	Representative Applications
Vinyl Alcohol	TP	Molding powder, water solutions, standard sheets, tubes, films and rods	Compression molding, extrusion molding, casting, forming, coating	Solvent and grease resistance, gas impermeability, water solubility	Low pressure mold lining, textile sizing, paper coating, hose for solvents and city gas, binders, aprons, gloves
Vinyl Butyral	TP TS	Liquid resins of varying viscosities, molding compounds, lacquers	Coating, impregnation, compression molding, injection molding, extrusion molding, calendering, adhesive	Excell. scuff resistance, low temp. flexibility, clarity, adhesiveness	Safety glass core, fabric coating, electrical instrument housings, adhesives, coating, furniture, household appliances
Vinyl Carbazole	TP	Molding compounds, solutions	Compression, injection and extrusion molding, impregnation, coating	High heat distortion temp., electrical insulation, moisture resistance	Electrical insulation and parts, cloth, paper impregnant
Vinyl Chloride	TP	Molding compounds, resin solutions, emulsions	Compression, injection and extrusion molding, calendering, casting, impregnation	Chemical and moisture resistance, nonflammable	Electrical insulation, tubing, washers, gaskets, plating rack and tank lining, shower curtains
Vinyl-Chloride Acetate	TP	Molding powder, solutions, dispersions, suspensions, standard sheets, films, shapes, tubes, rods	Injection, extrusion and compression molding, calendering, coating, impregnation, forming	Nonflammable, dimensional stability, chem. and moisture resistance, heat sealing	Printing plates, phonograph records, imitation leather, electrical insulation, chemical dispensers, windows, watch crystals, drafting instruments, lacquers (cans), radio parts, shower curtains
Vinyl Formal	TP	Liquid resins of varying viscosities, solutions, molding compounds	Coating, impregnation, compression molding, casting	Solubility	Wire insulator lacquer, coatings (for metals)
Vinylidene Chloride (Saran)	TP	Molding compounds, latex emulsions, lacquers, standard fittings, tubes, pipe, sheets, film, filaments	Injection molding, compression molding, extrusion molding, coating, impregnative forming	Excellent weather and chemical resistance, toughness	Pipe and fittings (solid and lined) for chemical ind., insect screening, coatings, packaging foils, tank lining, filter cloths, upholstery, containers, plating rack insulation

though "A" has slightly better utility or service characteristics. The structure of the product which is determined by the manner of use may be readily adaptable to a particular type of molding or could easily be formed from standard sheets or shapes. Then again, it may be in order to use a number of parts, of the same or different materials, cemented, mechanically jointed, or otherwise connected to form the product. Naturally, such physical properties as tensile strength, impact strength, flexibility, hardness, etc., affect the design and consequently have a direct bearing on the selection of a plastic.

Appearance, too, is of importance since when one goes through the list of plastics applications it is almost immediately apparent that a sizable portion of plastics go into products sold primarily on the basis of eye appeal. No other materials—except for perhaps marbles and semi-precious stones—can match the variegated color effects obtainable in cellulose nitrate or the rich tonal effects of the cast phenolics. Almost all of the various types of plastics can be colored with pigments or dyes as desired. In some instances the pigments or dyes tend to fade or leach on extended exposure to sunlight, weather changes or abnormal chemical environment. These factors must be taken into consideration in the selection of both the plastic and coloring agent.

In order to present as much information about the different plastic types in ready reference form, three tables are presented covering, respectively, general information, specific chemical resistance, and physical characteristics. Information in the tables is supplemented by the text.

Types and Forms of Plastics

To emphasize the number of different plastics—not including the synthetic rubbers—that are available from manufacturers, Table I contains a number of plastics whose applications are confined exclusively to such non-rigid forms as coatings, adhesives, sizings, etc. In addition, several of the plastics listed are available only in limited quantities for test applications and hence are not as yet classified among plastics "commercially available." As will be indicated further in this section, there is a definite criterion—as there are for other materials of construction for determining the commerciality of the various plastic types. On this basis the "limited" plastics may not have been sufficiently tested to warrant exclusion from a complete list.

Chemical Names

Table I lists all the different plastic types, alphabetically, by the chemical name generally used. This manner of tabulation was not used prankishly to add to the confusion already prevalent when one endeavors to select a particular plastic type from the arbitrary "groupings" or "families" established in the past. In view of the trend in the manufacture of plastic materials to form "alloys" of different types of plastics —as typified by vinyl chloride—vinylidene chloride copolymers—it is felt that the alphabetical listing will be more useful even at the present time. Similarly, the prefix "poly" has been dropped from such types as styrene and vinyl in the listing to emphasize the basic chemical building block of these resin types.

Definitions—Class of Plastics

Although definitions of most of the terms used in the plastic industry have been con-

zed in Manual No. 25, several are repeated herewith.

The terms "plastic" and "resin" are used synonymously in many instances; however, such usage is not always correct.

Resin signifies a state of matter as well as a chemical group and hence it cannot be given a rigorous definition. A resin may not possess all but will have most of the properties such as: insolubility in water; solubility in alcohols or ethers; solutions are sticky or adhesive and produce transparent films on drying; complete resistance to putrefaction or rancidity agents.

A *Plastic,* on the other hand, is a substance consisting entirely or in part of resins, which can be formed into a definite shape on application of heat and/or pressure, and which will retain this shape when returned to room conditions. Thus, plastics differ from resins in that they may contain inorganic salts, mineral fillers, pigments, etc., in addition to the resin base.

Both resins and plastics are divided into the following classes:

Thermoplastic — Materials which soften and remain soft permanently under heat, and

Thermosetting—materials which undergo a chemical change and are hardened by heating with or without pressure.

The line of demarcation between the above classes is sometimes not very distinct. A good example is aniline-formaldehyde, Table I, No. 4, which when the aldehyde to aniline (N-phenylaniline) ratio is on the order of 1.4 : 1, molding with a cure of about 3 min. yields a thermoplastic rubbery product. A longer cure may render the product thermosetting, although this is normally accomplished by increasing the aldehyde to a 2:1 ratio.

Other definitions are:

Casting Resins (or plastics)—resins prepared as liquids (usually syrupy) which on casting into molds can be hardened exclusively by heat or at room temperature by the action of incorporated "accelerators."

Cold Molded — a mixture of mineral and/or organic material containing resinous binders which, after pressing into the desired shape at room temperature, is baked to obtain optimum strength by "cure" of the binder. (Note: Compounds containing waterglass or cement binders are normally included in this category; however, such materials are not true plastics as defined.

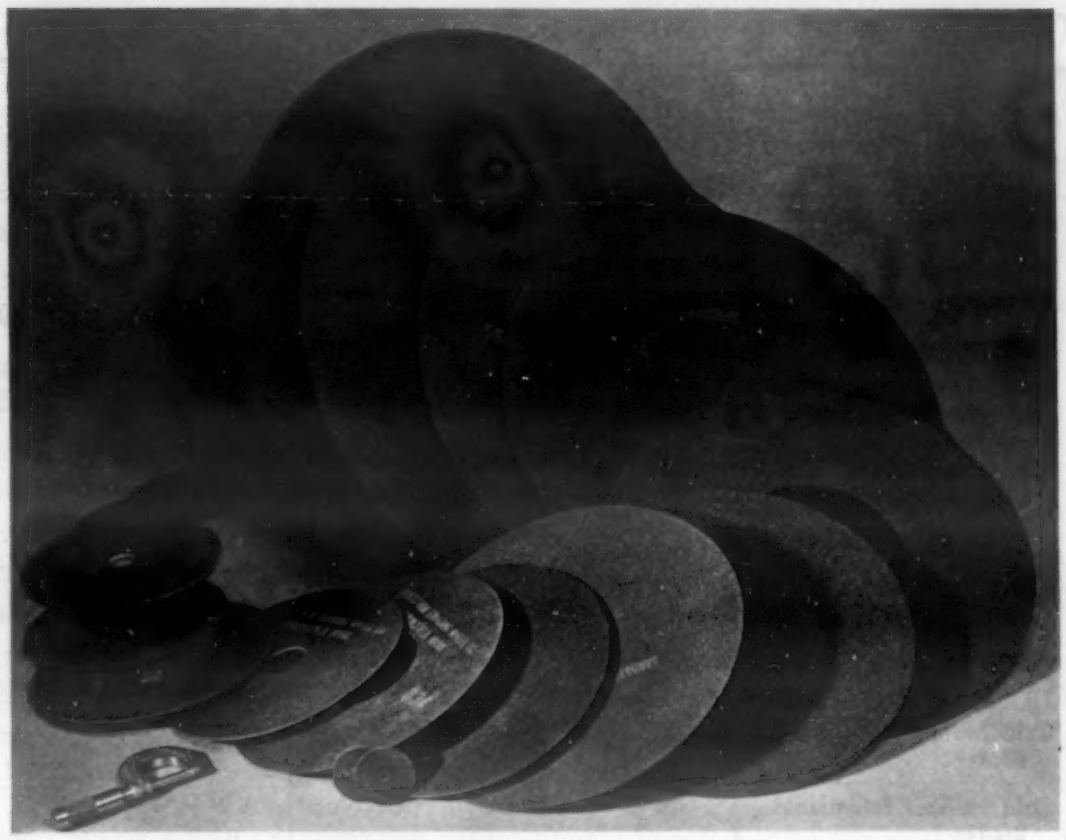
Elastomers—resins which, on vulcanization with such agents as sulfur, form materials with properties similar to those of rubber.

Since, as indicated previously, the current trend in plastic formulation is to form "alloys" or co-polymer resins having properties and characteristics differing from those of the individual resins, the following definitions should clarify the mechanism involved:

Monomer—the chemical structural unit which can aptly be termed the lowest common denominator of a resin. Monomers of some resins such as the acrylic (methyl methacrylate) and styrene are used as such in the form of casting resins.

Polymer—a chemical compound of relatively high molecular weight formed by a combination of a compound of lower molecular weight—a monomer.

Polymerization — the reaction affecting the combination as described above.



Plastic materials are widely applied as bonding materials. The grinding wheels shown here, made by J. G. Sandstrom Grinding Wheel Co., utilize special resins to produce the strength and accuracy required. (Photo: Courtesy Durez Plastics & Chemicals, Inc.)

Co-Polymer — a complex compound formed by two different substances or monomers polymerizing at the same time.

Forms Available

As indicated by, for example, phenol formaldehyde, a resin or plastic may be available in a variety of forms, each of which has at least one particular application. The nature of the resin form allows for a quick association with the methods of fabrication which are in themselves highly descriptive.

Solid—lumps, granules, or powder—applies to resins marketed as such for molding or use in formulation.

Molding Compounds — formulations of resins and plastics usually marketed in granular, flake, or powder form specifically for production of pieces by the various molding techniques, namely, compression, injection, extrusion, jet and transfer.

Liquid—the resin itself in liquid form with possible incorporation of accelerators for solidification and curing, fillers, pigments and dyes. Used for impregnation or coating of paper, fabric, etc., fibers; coating of metals, masonry; or casting. Viscous liquids are termed *semi-solids* in some instances.

Solution (varnish, lacquer) — resin dissolved in a liquid vehicle for application to materials as an impregnant, protective and/or decorative coating.

Emulsion—a mixture wherein droplets of a liquid resin are suspended in another liquid.

Suspension—a mixture of solid particles of a resin or plastic in a liquid. Viscous mixtures are denoted as *pastes.*

Dispersion—may refer to either or a combination of emulsion and suspension.

"Modified"—when prefixed to any of the above forms indicates that a substance has been added to the formulation for such reasons as

1. To lower the cost without appreciably affecting properties—substance called *"extender."*
2. To increase flow or flexibility — *"plasticizers."*
3. To specifically alter a property such as chemical resistance—*"modifiers."*

Standard Shapes—sheets, rods, tubes, special profiles, pipe fittings, etc., which can be used as such or worked into consumer products as indicated under "Methods of Fabrication."

Fibers—woven composite of small diameter, extruded *"filaments."*

Films—thin section, self-supporting sheets of resins or plastics. Sometimes called "foils."

Methods of Fabrication

Most of the terms used, such as casting, forming, machining, etc., need no explanation in that they are the same as used in the metals field. The methods which are unique to the plastics industry are—

Injection Molding—heated plastic particles are simultaneously fused and injected under pressure into the relatively cold cavity of a split die in which they solidify. Applicable to thermoplastic class almost exclusively.

Table II—Chemical Resistance

Resin Type	Acetic Acid 5%	Ammonium Hydroxide 10%	Hydro-chloric Acid 10%	Hydrogen Peroxide 3%	Nitric Acid 10%	Oleic Acid C. P.	Sodium Carbonate Solution 2%	Sodium Chloride Solution 10%	Sodium Hydroxide 1%
Acrylic Resins	N	N	N	N	N	N	N	N	N
Allyl Resins	SL SW	SL Etched	N	N	N	N	N	N	N
Aniline-Formaldehyde	N	N, SL Etched	SL Decomp	N	SL Decomp	N	N	N	N
Casein	SW	Decomp	Decomp	SW	Decomp	N	SW	N	Decomp
Cast Phenolics	N	Disc	N	Disc	N	N	Disc	N	Decomp
Cellulose Acetate	SW, N	Soft Disc	Decomp	N	Decomp	N	SW, N	N	Etched
Cell. Acet. Butyrate	N	Disc	N	N	Disc	N	N	N	N
Cellulose Nitrate	N	Etched Disc	N	N	N	N	Etched	Etched	N
Cellulose Propionate	N	SL Etched	N	N	Etched	N	N	N	N
Cold Molded Phenolic Binder	N	N	Decomp	N	N	N	N	N	Decomp
Cold Molded Bituminous Binder	N	Etched	Decomp	N	N	N	N	N	N
Ethyl Cellulose	N	N	N	N	N	Decomp	N	N	N
Melamine Resins	N	N, SL Disc	Disc	N	Etched	N	N	N	N
Phenol-Furfural	N	Etched	Etched	N	Etched	N	N	N	Etched
Phenolic Resins Molded	N	Etched	Etched	N	Etched	N	N	N	Etched
Phenolic Resins Laminated	Etched, BL	Etched	Etched	N	Etched, BL	N	Disc	Etched, SW	Etched
Polyamides (Nylon)	N	N	Decomp	SL Disc	Embrittled	N	N	N	N
Polyethylene	N	N	SW	N	N	SW	N	N	N
Silicon Polymers (Rubber)	N	N	N	N	SL Att	N	N	N	Att
Styrene Polymers and Co-Polymers	N	Disc	N	N	N	N	N	N	N
Tetrafluoroethylene (Teflon)	N	N	N	N	N	N	N	N	N
Urea Resins	N	N	Etched	Etched Disc	Att	N	N	N	N
Vinyl Butyral	Disc	Disc	Disc	Disc	Disc	Tacky	Disc	N	SL Disc, N
Vinyl Chloride	N	N	N	N	N	N	N	N	N
Vinyl Chloride Acetate	N	N	N	N	N	N	N	N	N
Vinylidene Chloride (Saran)	N	Embrittled	N	N	N	N	N	N	Disc

N - No Effect; Diss - Dissolved; Disc - Discolored; Decomp - Decomposed; SL - Slight; Soft - Softened; SW - Swelled; BL - Blistered; Att - Attacked.

Compression Molding—plastic particles heated and compressed in hot die to effect forming and also cure in the case of thermosetting materials.

Extrusion Molding—production of fixed contour shapes by pressing of heated, fused particles through an orifice die. Restricted almost exclusively to thermoplastics although equipment has recently been constructed to continuously extrude phenolic materials.

Jet Molding—A process similar to injection molding but used exclusively for molding of thermosetting materials.

Transfer Molding—a two-stage process whereby thermosetting materials are fused under heat and pressure in one chamber prior to transfer through an orifice into the mold.

Blow Molding—process wherein heated thermoplastic sheets, or a bubble is forced against the mold walls by air or gas pressure.

Laminating—Impregnated sheets of paper or fabric are either bonded together by the action of heat and pressure between hot plattens or are pressed onto the mold prior to curing or forming by a blanket.

Bag Molding—wherein the mold and material are enclosed and the air is subsequently exhausted from the enclosure. A modification of this method is also used to form thermoplastic sheets.

Hot Press Molding—the sheets are placed in a heated female metal die and formed to shape by hydrostatic pressure applied to

Sodium Hydroxide 10%	Sulfuric Acid 3%	Sulfuric Acid 30%	Water Distilled	Acetone	Carbon Tetra-chloride	Ethyl Acetate	Ethyl Alcohol 50%	Ethyl Alcohol 95%	Ethylene Dichloride	Heptane BR. –90 to 100 C	Toluene
N	N	N	N	Diss	Etched	Diss	SW	SW, Etched	Diss	N	Diss
SL Etched	N	SL Etched	N	N	N	N	N	N	N	N	N
N	Etched	Decomp	N	N	N	N	N	N	N	N	N
Decomp	SW	SW	SW	N	N	N	SW	N	N	N	N
Decomp	N	N	N	Soft	N	N	N	N	N	N	N
Decomp	N, SW	Etched Decomp	N	Diss	N, SW	Diss	Diss	Diss	SW	N, SW	N
Soft	N	N	N	Diss	SW	Diss	Soft, SW	Soft, SW	Diss	N	Soft, SW
N	N	N	N	Diss	N	Diss	N	Diss	Diss	N	Diss
SL Tacky	N	N	N	Diss	SW	Diss	SL SW	SW	Diss	N	SW
Decomp	N	N	N	N	N	N	N	N	N	N	N
N	N	N	N	Decomp	Decomp	N	N	N	Decomp	N	Decomp
N	N	N	N	Diss	Diss	Diss	Diss	SW	Diss	Diss	SW
N	Etched	Etched	N	N	N	N	N	N	N	N	N
Decomp	Etched	Etched	N	N	N	N	N	N	N	N	N
Decomp	Etched	Etched	N	N	N	N	N	N	N	N	N
Decomp	Etched	Etched	BL	N	N	N	N	N	N	N	N
N	SL Att	Decomp	N	N	N	N	N	N	N	N	N
N	N	N	N	N	SW	SW	SW	SW	Soft	SW	SW
Att	Att	Att	N	N	N	Soft	N	N	N	N	N
N	N	N	N	Diss	Diss	Diss	N	N	Diss	Diss	Diss
N	N	N	N	N	N	N	N	N	N	N	N
SL Disc	Etched	Etched	N	N	N	N	N	N	N	N	N
N	Disc	Disc	Disc	SW, Disc	SW	Etched	SW	Diss	Diss	N	SW
N	N	N	N	SW	N	SL SW	N	N	Diss	N	SW
N	N	N	N	Diss	N	Decomp	N	N	Diss	N	Rubbery
Embrittled	N	N	N	SL Att	N	SL Att	N	N	Diss	N	SL Att

rubber counter die.

Post Forming—cured laminated sheets composed of fabric impregnated with thermosetting resin can be heated and shaped to a limited extent in the same manner as metal is drawn with a punch and die.

Outstanding Properties

The laws of economics, as applied to plastics, require that each plastic type have a reason for its existence. This reason can be a single unique characteristic such as a physical property which would set an individual plastic above and apart from all others as far as the particular property is concerned. In cases where a single unique characteristic does not exist, a number of desirable properties may account for the commerciality of the plastic.

All resins and plastics are typified by poor heat conductivity, which accounts for warmness to touch. Similarly, all plastic surfaces exhibit a vitreous luster, which accounts for a pleasant appearance. All other properties, however, will vary from plastic to plastic. The significance of the various properties and, in particular, how these properties determine the selection of plastics materials for various uses will be discussed in subsequent sections.

Typical Applications

The various items given in this column in Table I were selected to illustrate the widest

possible application range of the different plastic types. Thus, it will be noted that a number of everyday items, such as buttons, toilet seats and radio housings, appear for several different plastic types. Evidently all the plastics for which such applications are indicated can be expected to give satisfactory service. Then why, for example, are portable or table-top radio housings made from cast phenolics as well as ethyl cellulose, among others? Both materials have adequate electrical insulation, rigidity, and weathering properties. However, one radio manufacturer may prefer to accept the higher cost of the cast phenolic housings in order to obtain characteristic color effects that he feels will help sell the radio. By the same token, other manufacturers may prefer to use the less costly and tougher ethyl cellulose housings which can be produced in pleasing colors. In both instances the cost of the housing will probably be reflected in the selling price of the radio.

It should not be assumed that the different plastics are by any means limited to the applications listed. The listing is intended as a helpful guide to those readers to whom plastics may not be an everyday affair and not as a straight jacket restricting the selection of plastics to specific items.

Resistance of Plastics to Chemicals

The balance of the manual will discuss the rigid types of plastics that are of prime interest to both plastics fabricators and consumers. Thus, resins or plastics used exclusively for coatings or adhesives will not be further described.

Whereas the information given previously is rather general, the information presented in Tables II and III (Chemical Resistance and Physical Properties, respectively) will be much more specific from the standpoint of selection of plastics. It should be borne in mind that both chemical resistance and physical properties of many of the plastics will vary with the composition of the resin base, the nature and quantity of the plasticizer, filler or pigment, and the condition of the plastic—in particular, the plastic surface. This latter factor is of no mean importance, since the surface of plastics have what is known as a "case" or thin film section that is normally more resistant to chemical environment than the plastic beneath this surface. Thus, a freshly cut or machined plastic will in most instances be more susceptible to attack on the opened surface. This phenomenon parallels that of metals and, like metals, it is necessary to activate the surface of plastics by roughening with abrasive or chemicals prior to adhesive bonding or metallizing.

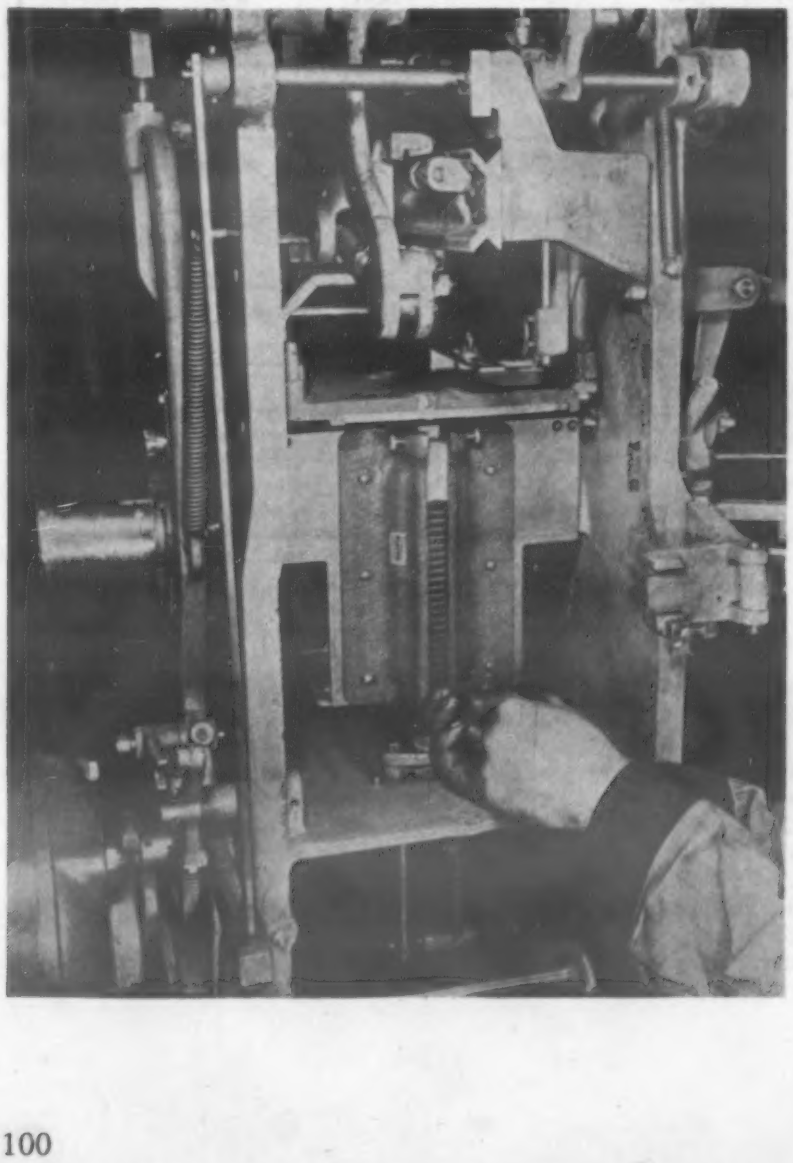
With regard to chemical resistance, it is, of course, best to test the model of a product or a section cut from plastic material to be used in the product under actual service conditions or accelerated conditions simulating service. In accelerated testing, the solution or environment may be made stronger, the temperature may be increased or decreased abnormally, the humidity or light intensity may be maintained in excess of normal service, the cycles of environmental changes may be hastened, etc. In short, all factors that may affect the plastic in service can be intensified in test. The accelerated test is a most useful tool when used for comparison of several plastics in order to determine *relative* resistance or durability. It should be noted that these tests cannot usually be translated into the number of years that a plastic or product can be expected to give good service unless sufficient accurate "life" service information is available—this often means many years of periodic examinations of a relatively large number of test pieces, and much of this work is already in progress on a number of items.

One such relative test has been standardized by the American Society of Testing Materials, ASTM, D 543-43, and entails the complete immersion of test strips in a number of different chemical solutions for seven days at a temperature of 77 F. The range of chemicals specified for use in the test are those commonly used either in the household, the laboratory, or in industry as indicated by the following:

- Acetic acid—5%—vinegar strength
- Ammonium hydroxide—10%—about 2 or 3 times that of household cleaner strength
- Hydrochloric acid—mineral acid
- Hydrogen peroxide—3%—antiseptic concentration oxidizer or bleach
- Nitric acid—10%—mineral acid-oxidizing
- Oleic acid c.p.—organic acid-food greases
- Sodium carbonate solution—2%—household cleaner
- Sodium chloride—10%—higher strength than sea water
- Sodium hydroxide—1 and 10%—household cleaners
- Sulfuric acid—3 and 30%—mineral acid-dehydrator
- Acetone—nail polish remover and thinner
- Carbon tetrachloride—dry cleaning fluid
- Ethyl acetate—lacquers, perfumes, flavors
- Ethyl alcohol—liquors, rubbing alcohol
- Ethylene dichloride—solvent, adhesive component
- Heptane—gasoline component
- Toluene—industrial solvent

Effects of these chemicals on plastics may be evidenced by solution of the plastic, disintegration, embrittlement, softening, swelling, surface etching, change of color, etc. In order thoroughly to evaluate the effects of these chemicals, it is advisable to make pertinent physical tests on a number of comparable specimens before and after immersion.

Although the chemicals listed in Table II cover a wide range of possibilities, most of the plastic material suppliers can supply additional information regarding the stability of different formulations in other specific chemicals.



Resin impregnated plastic moldings are used for label holders on packaging machinery because of low cost and durability. (Photo: Courtesy American Cyanamid Co.)

More and more large sections of molded or formed plastics are being used for such applications as refrigerator door panels. (Photo: Courtesy Westinghouse Electric Corp.)

Physical Properties of Plastics

A casual glance at Table III will serve to indicate immediately that there is a wide variance in physical properties of almost all the different plastic types. The values given cover a range that is available for each plastic. However, it is not always possible to obtain, for example, maximum impact strength with maximum tensile strength, or maximum flexural strength with a particular color that requires high pigment proportion. In most instances the ultimate formulation used will be a compromise wherein some of the properties will be improved to the detriment of others. In view of this situation, most of the material manufacturers have available a number of standard formulations of plastics having rather special property ranges in addition to the usual grades of "general purpose" material.

The properties described are those used most frequently in the selection of plastics from the standpoint of general application and utility. There is, of course, additional data available on properties of specific interest to the plastic molder, to lens manufacturers, and to the electrical and radio engineer among others. The description of the significance of all these specialized properties is beyond the scope of this manual, and reference should be made to the manufacturer for additional information.

The significance of the different properties listed are as follows:

Specific Gravity—important from standpoint of volume-cost relationship.

Flammability—the upper line gives a qualitative description of what happens when a flame is applied to the plastic surface. As indicated, some plastics ignite more readily than others. Similarly, on removal of the flame the plastics which are classified as self-extinguishing will cease to burn while the others will burn at the rates indicated.

Water Absorption—all plastics, with the unique exception of tetrafluoroethylene (Teflon), are adversely affected by exposure to sunlight and varying humidity and temperature. This is undoubtedly due to the tendency for plastics to "breathe" with changes in environment until the repetition normally results in marked reduction in strength properties and warpage. The water absorption values serve as a barometer with regards to this tendency, with the higher values indicating an increased tendency towards deterioration by weathering.

Refractive Index—the index of refraction of a transparent plastic is a measure of the speed at which the material will transmit light as compared to air taken at unity. A value in excess of 1 indicates that light travels slower in the material than in air and, therefore, will be bent or deflected on entering the material. The higher the value the greater the bending effect.

Tensile Strength—this is the maximum stretching load per unit area of original cross-section required to break a test specimen. This property will vary considerably for most plastics, depending upon the molding characteristics, prevalent humidity and temperature.

Modulus of Elasticity in Tension—the value allows for the determination of the stretch in the plastic on application of loads insufficient to cause permanent deformation of the plastic on removal.

Flexural Strength—the breaking strength of a plastic when tested as a beam loaded centrally between supports.

Impact Strength—a measure of the toughness of a plastic with higher values indicating higher resistance to breakage by shock impacts.

Hardness—higher values indicate greater ability for the surface to withstand indentation.

Distortion Temperature—the low value given indicates the temperature above which noticeable deformation may be expected on application of a load. The upper limit given is the temperature above which the plastic will deform of its own accord or decompose.

Thermal Conductivity—a measure of the ability of the plastic to transmit heat. Plastics having lower values will feel warmer to the touch since the heat is not transferred away from the surface rapidly.

Specific Heat—indicates the quantity of heat required to raise the temperature of a plastic material.

Thermal Expansion—affords a measure of the relative change of dimension of different plastics with change in temperature.

Dielectric Strength—the maximum potential or voltage that a plastic can withstand without breakdown, as indicated by a sudden and marked decrease in voltage and corresponding

Table III—Physical Properties

Resin Type	Specific Gravity	Flammability and Burning Rate	Water Absorption (Note 1) %	Color Possibilities	Refractive Index N25/D	Tensile Strength, Psi.	Modulus of Elasticity in Tension, Psi. x 10^5	Compressive Strength, Psi.
Acrylic Resins	1.16-1.20	Readily ignited, burns slowly	0.3-0.5	Transparent Unlimited	1.49-1.51	6000-1000	3-5	11000-15000
Allyl Resins	1.32-1.40	Moderately ignitable, slow to self-extinquishing	0.05-0.20	Transparent Unlimited	1.50-1.57	5000-6000	4.5	19000-23000
Aniline-Formaldehyde	1.22-1.25	Readily ignited, self-extinguishing	0.01-0.08	Translucent Dark Colors	—	8000-10000	5-6	20000-25000
Casein	1.35	Moderately ignitable, self-extinguishing	7-13	Translucent Unlimited	—	10000	5.1-5.7	25000-54000
Cast Phenolics	1.25-1.34	Difficult to ignite, self-extinguishing	0.2-2.0	Transparent Limited	1.58-1.66	2000-9000	4-18.8	4000-34000
Cellulose Acetate	1.27-1.37	Readily ignitable to 'non-flammable,' burns slow	1.5-6.0	Transparent Unlimited	1.46-1.50	1500-8200	0.6-3.5	4000-36000
Cell. Acet. Butyrate	1.15-1.24	Readily ignited, burns slow	1.0-2.5	Transparent Unlimited	1.46-1.49	1400-6700	0.5-2.0	7500-23000
Cellulose Nitrate	1.35-1.45	Very readily ignited, burns extremely fast	0.7-4.0	Transparent Unlimited	1.50-1.51	3000-10000	2-4	20000-30000
Cellulose Propionate	1.17-1.22	Readily ignited, burns slow	1.0-1.7	Transparent Unlimited	1.475-1.490	2800-6000	1.5-2.8	—
Cold Molded Organic Binder	1.87-2.15	Bit. moderately ignitable, burns slow	0.6-2.0	Opaque Dark Colors	—	—	—	6000-16000
Ethyl Cellulose	1.07-1.18	Readily ignited, burns slow	0.7-2.5	Transparent Unlimited	1.47	3000-10000	0.6-5.0	5000-20000
Melamine Resins Molded	1.45-1.55	Difficult to ignite, self-extinguishing	0.08-0.6	Translucent Unlimited	—	6000-13000	10-15	26000-43000
Phenol-Furfural	1.3-2.0	Difficult to ignite, self-extinguishing	0.02-2.5	Opaque Limited	—	4000-8500	7-45	16000-36000
Phenolic Resins Molded	1.30-1.45	Difficult to ignite, self-extinguishing	0.03-3.0	Opaque Limited	1.5-1.7	7000-10000	7-12.5	10000-35000
Polyamides (Nylon)	1.14-1.15	Moderately ignitable, self-extinguishing	1.5	Translucent Unlimited	1.53	9000-10500	3.0-3.25	14000-18000
Polyethylene	0.92-0.93	Readily ignited, burns slow	<0.01	Translucent Unlimited	1.52	1800-3000	0.15	—
Silicon Polymers Rubbers	1.40-2.04	Difficult to ignite, self-extinguishing	0.25-1.0	Opaque Unlimited	—	200-650	—	—
Styrene Polymers and Co-Polymers	1.05-1.07	Readily ignited, burns slow	0.04-0.06	Transparent Unlimited	1.59	3000-9000	1.7-4.7	11500-17000
Tetrafluoro-ethylene (Teflon)	2.1-2.3	Non-flammable, melts & decomposes	0.00	Opaque Limited	1.35	2000-4500	0.55-0.65	1700
Urea Resins	1.45-1.55	Difficult to ignite, self-extinguishing	0.75-2.0	Translucent Unlimited	1.54-1.56	6000-13000	12-16	25000-38000
Vinyl Butyral	1.05-1.50	Readily ignited, burns slow	1.0-3.0	Transparent Unlimited	1.47-1.49	4000-8000	3.5-4.0	—
Vinyl Chloride	1.2-1.6	Difficult to ignite, self-extinguishing	0.1-0.6	Transparent Unlimited	—	1000-9000	—	—
Vinyl Chloride Acetate	1.30-1.45	Difficult to ignite, self-extinguishing	0.05-0.15	Transparent Unlimited	1.52-1.53	4500-8500	3.5-4.1	9000-11000
Vinylidene Chloride (Saran)	1.65-1.72	Very diff. to ignite, self-extinguishing	<0.1	Translucent Most Colors	1.60-1.63	4000-7000	0.7-2.0	4500-8500

Notes: (1) ⅛-in. thick section—24 hr. (2) ½-in. by 2-in. bar. (3) CAL/CM²/SEC/C/CM x 10^{-6}.

Flexural Strength, Psi.	Impact Str. Izod. Ft. Lb. Per In. of Notch(2)	Hardness Rockwell	Distortion Temp. Range, F	Thermal Conductivity (3)	Specific Heat Cal/C/Gm.	Thermal Expansion Per Deg. $Cx10^{-5}$	Dielectric(1) Str. ⅛ In. Thick Volts/Mil	Dielectric Constant 10^3 Cycles	Power Factor 10^3 Cycles
10000-19000	0.2-0.6	M60-112	120-200	4-6	0.35	8-9	400-500	3.2-3.5	0.04-0.07
8000-14000	0.2-0.4	M95-115	140-225	4.8-5.0	0.26-0.55	5.5-11.0	500-1275	3.25-3.8	0.01-0.018
12000-20000	0.32	M115-120	180-240	2.6	0.4	5-6	400-650	3.7	0.004
10000-18000	1.0	M-70-1000	300-325	—	—	4.1-6.8	400-700	6.1-6.8 (10^6 Cycles)	0.052 (10^6 Cycles)
2000-14000	0.25-0.60	M20-120	95-3000	3-8.5	0.3-0.4	3.3-15	45-450	5.5-30	0.01-0.3
2000-14000	0.4-6.2	R40-125	100-220	4-8	0.3-0.45	8-16	200-365	3.5-7.0	0.01-0.06
4000-12000	0.5-9.5	R35-120	115-220	4-8	0.3-0.4	11-17	250-400	3.3-6.3	0.01-0.04
6000-15000	2.0-8.0	R90-120	120-165	3.1-6.0	0.34-0.40	9-16	250-600	6.2 (10^6 Cycles)	0.07-0.10 (10^6 Cycles)
4800-10000	0.8-11.4	R63-104	120-220	4.8	0.3-0.4	12-19	370-425	3.1-3.5	0.0075-0.013
3800-9500	0.4	M35-65	500	—	—	—	50-85	6.0 (10^6 Cycles)	0.07 (10^6 Cycles)
4000-12000	2.0-11.6	R50-110	100-220	4-7	0.3-0.5	10-20	400-600	2.5-4.0	0.005-0.03
9000-16000	0.24-1.5	M110-125	210-400	10-17	—	2.0-4.5	300-450	7.6-8.8	0.015-0.035
8000-20000	0.2-4.8	B55-75	240-400	3.5-20	0.25-0.4	2-7	200-500	4-20	0.01-0.28
8000-17000	0.2-10	M95-120	240-400	3-16	0.28-0.4	1.5-7.5	200-450	4.5-15	0.007-0.4
11000-13000	0.8-1.8	M80-90	170-350	6.0	0.4	10.0-10.3	250-400	4.0-5.0	0.02-0.05
1500-1700	3.0	R25-35	110-212	6.0-8.0	0.53	18	500-700	2.25-2.3	0.0003
—	—	—	350	—	—	—	260-450	3.2-7.4 (10^6 Cycles)	0.0004-0.003 (10^6 Cycles)
4800-19000	0.25-0.9	M55-95	150-190	1.8-2.0	0.32	6-8	450-650	2.5-2.7	0.00005-0.0005
2000	4.0	—	250-400	6	0.25	9	450	2.0	<0.0002
10000-18000	0.24-0.36	M110-122	170-280	7.0-10	0.4	2.0-4.5	250-400	6.3-9.0	0.028-0.055
10000	0.8-1.2	—	115-140	—	—	8-22	350-400	3.58-6.1	0.0075-0.04
—	—	—	150-175	3.9-4.0	0.3-0.5	—	300-425	4.2-5.5	0.09-0.16
7500-14000	0.25-0.50	—	125-135	4.0	0.24	6.9	380-425	3.1-3.2	0.011-0.013
14000-17000	2.0-8.0	M50-65	150-200	2.2-3.0	0.32	16-19	300-400	3-5	0.03-0.15

increase in current on test.

Dielectric Constant—the relative value which determines the quantity of electrostatic energy that may be stored in a given volume of plastic per unit potential gradient at the frequency indicated. The lower values indicate more desirable dielectric properties important for electrical insulation.

Power Factor—ratio of the quantity of current which produces heat in a material to the total alternating current flowing. A low value is indicative of a more desirable insulator, particularly for high frequency applications.

The above are the physical properties of most interest to designers primarily from the standpoint of structural and dimensional characteristics. Other characteristics of importance may be determined by such tests as

Stiffness
Shear
Abrasion wear
Scratching
Accelerated weathering
Colorfastness to light
Distortion under heat, and other tests

As will be indicated later, it is preferable that these tests be performed either on a model of the product or a piece cut from the model made with the plastic material under study.

What Plastic to Use

The question "What plastic to use" often requires a coalition of a number of different specialists to decide. The usual steps start with the idea for a product on paper, which is limited in that some imagination is required in order to "see" the product in three dimensions. Therefore, in almost all instances a scale model is constructed for use in discussions between the originator, the designer, the fabricator with his staff including the mold maker, and sales personnel. Each has a specific function in the preparation of a product for the market. However, all join to some extent in the selection of the most suitable plastic material. The designer's work consists of making the necessary drawings and models incorporating the basic ideas of the originator in a product that would permit for fabrication and sale. Almost always the designer is well aware of sales appeal and possibilities. However, he may not be entirely aware of the fine points of fabrication and material properties to enable him to select the most suitable plastic for the particular application. These points are usually taken up with the fabricator and his staff or with independent mold designers and materials engineers whose experience and background enable them to recommend not only the type of plastic but also the best formulation.

The selection of a particular plastic formulation may involve some minor changes in the design commensurate with the molding or forming characteristics of the plastic. For example, the wall thickness may be changed, stiffening ribs may be added, additional draft may be allowed to minimize distortion on removal from the mold, etc. Such changes should be made on the model or preferably on low cost test molds or forming dies in order to thoroughly evaluate the product from the utility and sales standpoint before going to the relatively expensive production molds and dies.

Utility evaluation can be boiled down to the question—Will the product perform satisfactorily under conditions of *normal* usage? It should be noted that regardless of how well-designed the product appears and the quality of the material used, the ultimate criterion remains the performance of the product as marketed. Therefore, it is not only necessary to make actual or simulated service tests prior to production but to continue these tests on production samples to maintain a satisfactory product quality. Very often an inadvertent change in the material formulation, variation in the molding or forming conditions, unfavorable storage conditions in the plant, or other factors, may render a sizable number of pieces unfit for sale. The possibility of defects reaching the consumer should be minimized by a continuation of testing, which may not have to be destructive in some instances, during production. This factor has been stressed to indicate that selection of the proper plastic material and proper production techniques does not mean the end of the fabricator's responsibility.

Returning to the problem of material selection, the following are some examples of how a plastic can be chosen for a particular application from the information given in the tables:

Flower Pot—attractive color, low cost large quantity production are the specifications.

Large quantity production and colorability indicate an injection molded thermoplastic. Further, the plastic must have a low water absorption rate so as not to become deformed by the constant dampness inside the pot. Reference to the Water Absorption Rate column in Table III shows both Styrene and Vinyl Chloride Acetate to have low rates, with Styrene the better of the two as regards this property.

Perambulator Hand Bar Cover—specifications—highly attractive variegated coloring, toughness weather resistance.

Examination of Table I indicates that Cellulose Nitrate is most suited for this application since it is available in variegated colored tubing, and is both tough and moisture resistant.

Distinctive Door Knob—natural rose embedded in transparent plastic.

Selection from information in Table I would indicate a casting resin of the Allyl or unsaturated polyester type that could be cast around the rose and attachment insert. Allyls are best suited from standpoint of high optical clarity and surface hardness.

Washing Machine Agitator—specifications: high impact strength, resistance to abrasive wear, inertness to soaps, boiling water, smooth lustrous surface.

The properties of high impact strength, relatively large size, surface hardness are those indicated for the thermosetting phenol formaldehyde resin in Table I. Table II shows that the molded phenolic resins are usually etched by dilute alkalis (ammonium hydroxide, and sodium hydroxide) that may be present or added to the wash solution. However, a special formulation is available which has adequate alkali resistance in addition to the other desirable characteristics that make phenolics best suited for this application.

Housing for Facial Vibrator—toughness, electrical resistance, appearance, moldability.

A cellulose acetate formulation, pointed towards toughness and high electrical resistance, would be a satisfactory selection since it meets all specifications and is moderate in cost.

Flashlight Housing—for military use in all climates—in this instance important features would be toughness, and maintenance of properties over wide temperature range in addition to light weight. From Table I the choice would be between Ethyl Cellulose and Cellulose Acetate Butyrate, with the former more desirable in view of higher toughness and lower density.

Chip Holder—simulated marble or gem stone.

Cast phenolics would be the selection for the holder on the basis of color effects obtainable and adaptability of the part to production by casting. For uniformity, the chips can also be produced in different colors with the cast phenolic resin.

Shower Curtain—water resistance, availability in flexible sheeting, colorability.

Vinyl Chloride Acetate would be selected for this application on basis of general information given in Table I and the low water absorption rate given in Table II.

The list of typical problems in the selection of plastics can, of course, be extended to cover all the different types given in Table I. However, it is felt that with the examples and information presented the reader will become somewhat adept at choosing those plastics that warrant consideration prior to the final selection of the most suited plastic. In addition, the purpose of the manual will also be served if such personnel as purchasing agents, materials engineers, and others in similar positions make it their custom to inquire as to the specific type of resin used in an article offered to them in order that they may use the tables given herein to determine whether the selection is a proper one.

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September, 1948

Temper Designations for Aluminum Alloys

In keeping with the need for a system of temper designations for the aluminum alloys that would permit sharper definition of the tempers, the basic system has been expanded by the Aluminum Co. of America. While the principle of the system of nomenclature remains unaffected, tempers of the cast and wrought alloys may now be specified more accurately by addition of one or more digits to the code number.

As the basic system has been adopted by the aluminum industry generally, and the present modification of it is a logical development that provides added clarity within the structure of the system, it is expected that the industry will take up the new designations also.

In the present system, all alloy designations remain as heretofore. The changes occur in the coding to indicate the fabrication or heat treatment of the alloy. The scheme followed is:

—F *As fabricated.* When the metal is not heat treated nor intentionally strain hardened, but has acquired some temper in the forming process, this symbol follows the alloy number.

—O *Annealed, recrystallized.* The softest temper obtainable in the wrought alloys is indicated.

—H *Strain hardened.* The old system of indicating a fully strain hardened material by —H, and of using fractions preceding the letter to show lesser degrees of hardness has been changed to the use of two or more digits following the letter. The first digit indicates the combination of operations used, and the following digit or digits show the final strain hardening in the material.

—H1 is used with alloys that have been strain hardened only.

—H2 indicates a strain hardening and partial anneal.

—H3 shows that the alloy has been strain hardened and then stabilized.

The digit or digits following these symbols may be correlated to the formerly used designations for degree of strain hardening by using ¼ H = 2, ½ H = 4, ¾ H = 6, H = 8. The nonstandard "extra hard" temper is represented by 9. thus, 52S—H33 indicates the 52S alloy in the strain hardened and stabilized state, with the final hardness between the ¼ H and ½ H degrees.

—W *Solution heat treated.* As the alloys, when given the solution heat treatment only, are subject to natural aging, this state is unstable. The "W" designation must therefore be modified by stating the period of aging.

—T *Stable heat treated tempers.* Stable tempers other than —F, —O, and —H, produced by heat treatment with or without strain hardening, are designated by —T, followed by one or more digits. The numbers 2 to 19, inclusive, are used to designate definite combinations of basic treatments. Some other variation in treatment, resulting in different properties in the alloy, would be indicated by adding another digit or digits to the designation.

—T2 indicates the annealing of cast alloys, to improve ductility or dimensional stability.

—T3 is used when solution heat treatment is followed by cold working to improve strength, or where the results of cold working are recognized in specifications.

—T4 designates a solution heat treatment followed by natural aging to a substantially stable condition, and is used when the alloy is not cold worked after heat treatment, or when specifications do not recognize the effects of minor cold working.

—T5 alloys are artificially aged without prior solution heat treatment. Mechanical properties and dimensional stability are improved.

—T6 applies to alloys that have been solution heat treated and then artificially aged without an intervening cold working, or for which the effect of any such cold work is not recognized in specifications.

—T7 indicates a solution heat treatment followed by stabilization. The temperature and time for stabilizing are carried beyond the point of maximum hardness to provide control of grain growth and residual stresses.

—T8 is applied when solution heat treatment is followed by cold working to improve strength, or when specifications recognize the effect of such intermediate cold working as may be done; artificial aging completes the basic operations.

—T9 is used when the cold working follows the solution heat treatment and artificial aging.

—T10 indicates that the alloy has been subjected to an artificial aging treatment, followed by cold working.

Again, the digit or digits following the designations given above are used to indicate a variation of the basic treatment given, and so codify explanations that until now had to be added as parenthetical expressions. For instance, the cast bearing alloy offered as an artificially aged product cold worked about 4% was formerly designated "750-T5, cold worked approximately 4%." Under the new nomenclature it becomes 750-T101, the final digit indicating cold working to a slight degree. Likewise, the alloy 61S-T under the old system becomes 61S-T6 under the new, the "T6" indicating that this particular material has been solution heat treated and then artificially aged without any cold working of consequence.

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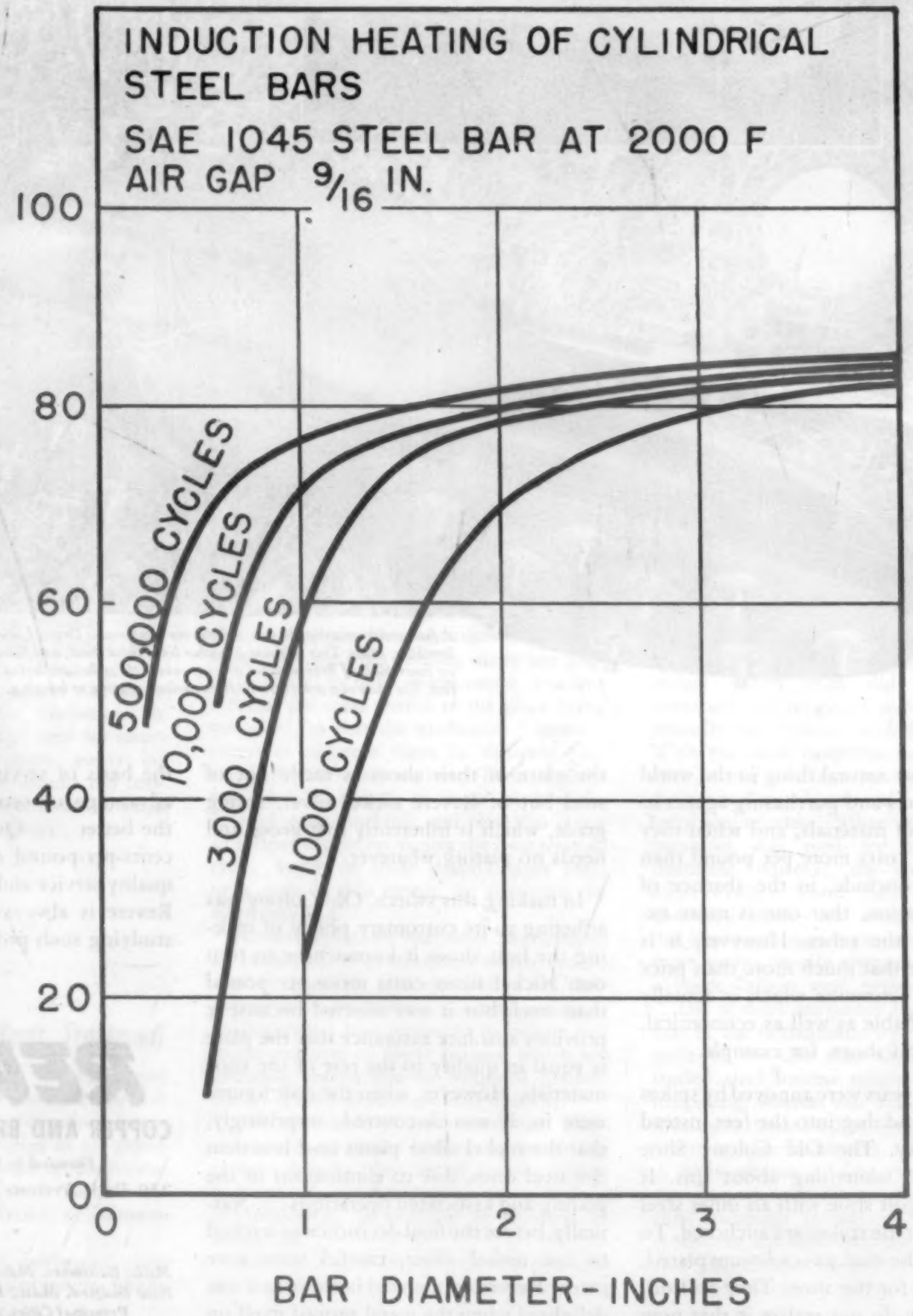
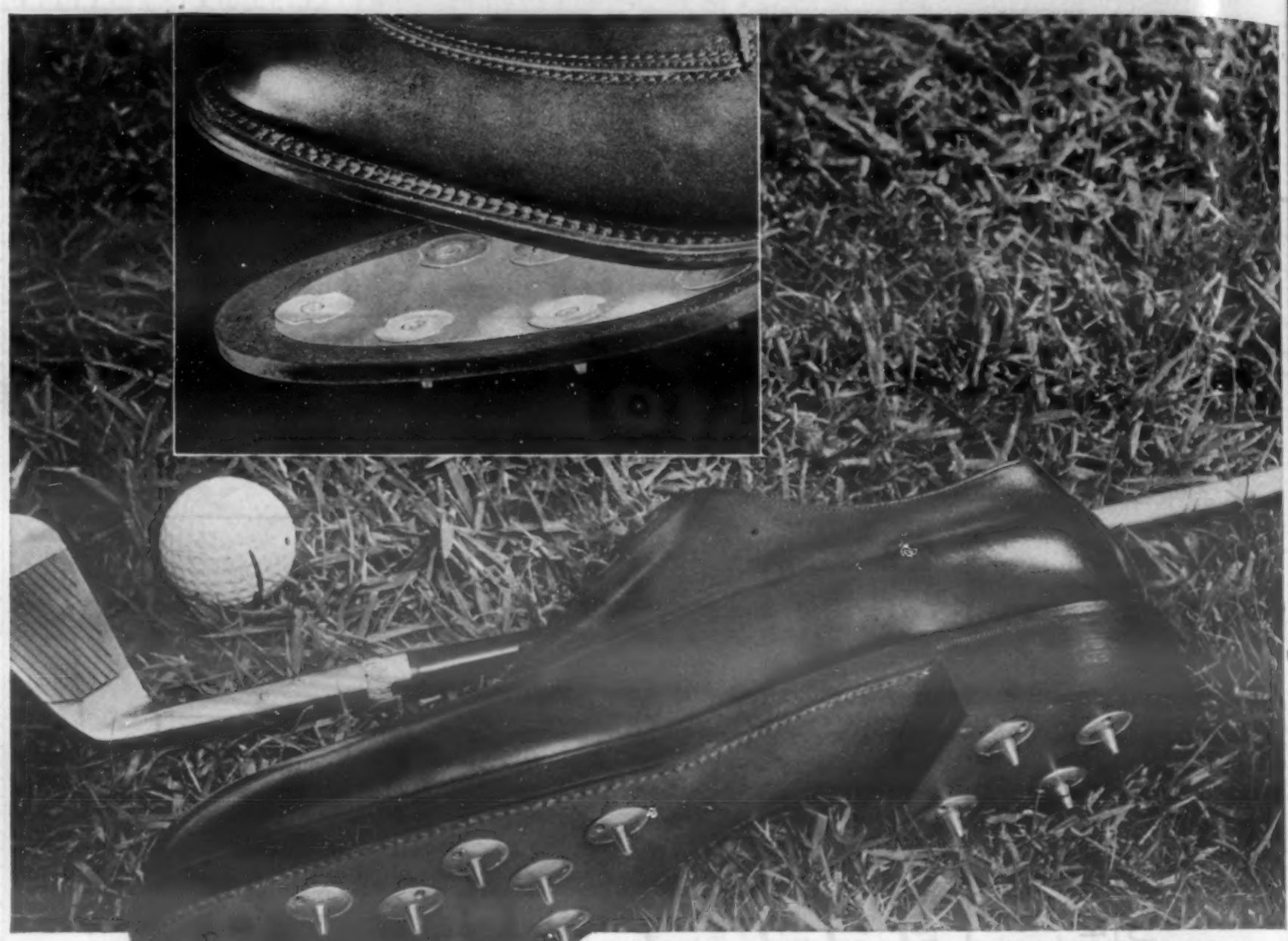
Induction Heating of Cylindrical Steel Bars

The relationship between current frequency and size of the workpiece in induction hardening of steel has been a subject for much discussion by heat treat engineers. Results of much research and of a great amount of work in the field are given by the Tocco Div., Ohio Crankshaft Co., in the curves shown below. The efficiency of heating of carbon steel bar stock is plotted against diameter of the bars for a range of frequencies. The steel was heated through and through to 2000 F, with an air gap of 9/16 in. between the surface of the bar and the inductor.



Prepared by the Tocco Division of the Ohio Crankshaft Co.

A CASE IN WHICH AN "EXPENSIVE" METAL PROVES MORE ECONOMICAL AS WELL AS BETTER



A four-eyelet moccasin blucher, built on the comfortable Drury Lane last by Old Colony Shoe Company, Brockton, Mass. This golf shoe is leather lined throughout, and features the Sportaid Spike Stabilizer, an inner plate of Revere nickel silver to which the spikes are locked, so they cannot tip or press into the foot. The plate also prevents soles from curling, sagging or lumping.* **® Old Colony Shoe Co.*

IT is the most natural thing in the world for engineers and purchasing agents to check prices of materials, and when they find that one costs more per pound than another, to conclude, in the absence of other information, that one is more expensive than the other. However, it is often the case that much more than price is needed to determine which is actually the most desirable as well as economical. Take these golf shoes, for example.

Golfers for years were annoyed by spikes that tipped, and dug into the feet instead of the fairway. The Old Colony Shoe Company did something about this. It developed a golf shoe with an inner steel plate to which the spikes are anchored. To prevent rust, the steel was cadmium plated. Golfers went for the shoe. They still do, but what they do not realize is that now the plate in their shoes is made not of steel but of Revere nickel silver, spring grade, which is inherently rust-proof and needs no plating whatever.

In making this switch, Old Colony was adhering to its customary policy of making the best shoes it knows how to turn out. Nickel silver costs more per pound than steel, but it was selected because it provides absolute assurance that the plate is equal in quality to the rest of the shoe materials. However, when the cost figures were in, it was discovered, surprisingly, that the nickel silver plates cost less than the steel ones, due to elimination of the plating and associated operations . . . Naturally, before the final decision was reached to use nickel silver, careful tests were made. Revere cooperated in these and was delighted when the metal proved itself on the basis of service. That it also has the advantage of economy is just so much the better . . . Quite often it is true that cents-per-pound are not as important as quality service and cents-per-finished-part. Revere is always glad to collaborate in studying such problems.

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MATERIALS & METHODS

DIGEST

A selective condensation of articles — presenting new developments and ideas in materials and their processing — from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

Plastic Replicas for Surface-Finish Measurement

The precise measurement of surface finishes is no longer just a laboratory tool but is rapidly becoming a means of commercial inspection. While small parts can easily be brought to the inspecting machine, large heavy components are more of a problem. Moreover, it is sometimes necessary to examine surfaces that are awkwardly located or even inaccessible to the pick-up. These difficulties can be overcome by the use of a plastic replica described by J. Pearson and M. R. Hopkins in the May 1948 issue of the *Journal of the Iron and Steel Institute* (English).

The plastic is a liquid mixture of monomeric and polymeric methyl methacrylate, which flows into the smallest irregularities without entrapping air. Adhesion between the plastic and the metal is reduced by the addition of tributyl citrate. The plastic is cured at room temperature within about 40 to 60 min. by ultra-violet light. This short curing time is made possible by the use of very thin films of plastic with a backing of Perspex sheet.

Measurements of mill rolls confirmed that the technique could be successfully employed under industrial conditions. The accuracy of reproduction was so good that other uses are proposed for the replicas. The fine detail of polished and etched specimens was well reproduced even at 700 magnifications. Therefore, these replicas could be used for the metallographic examination of large objects where the cutting of specimens is prohibited. The replicas also make excellent transparencies for projection. It is possible that they could be used for interferometric studies and there seems no reason why this technique should not considerably speed up the preparation of silica replicas for electron microscopy.

Uses of Isothermal Heat Treatment

What is isothermal heat treatment and what can it do are questions that are still widely discussed. These questions were ably answered by J. M. Hodge in his paper, "Principles and Applications of Isothermal Heat Treatment," presented before the Summer meeting of the *Society of Automotive Engineers* in June.

He pointed out that isothermal heat treatment, in which transformation ideally occurs at a single temperature, permits precision heat treatment to the specific microstructures desired for a particular application. In conventional heat treatment to tempered martensite, for example, although it permits the attainment of optimum properties in respect to strength and ductility if properly carried out, it has several inherent disadvantages. The transformation to martensite, occurring during the rapid cooling through the martensite temperature range, sets up high stresses; these are augmented by a large temperature gradient through the cross section of the piece being quenched, so that the martensite formation occurs at different times in different portions of the cross section. These stresses may be high enough to cause micro-cracks or even gross cracking, and may also result in serious distortion during the heat treating cycle. Some of these disadvantages may, to a considerable extent, be overcome by martempering.

Austempering, on the other hand, offers an isothermal heat treatment which can be used alternatively with quenching and tempering or martempering. Austempering is an isothermal heat treatment to bainite and microstructures of lower bainite, which are generally comparable to tempered martensite in respect to strength and ductility.

The usefulness of isothermal heat treatment is by no means limited to transformation to bainite. Isothermal transformation to pearlite also represents a very wide field of usefulness, particularly in relation to annealing.

Another paper on one specific phase of isothermal heat treatment appeared recently in *Stahl und Eisen* (German), Apr. 22, 1948. This article by W. Connert & H. Kiessler covers an extensive investigation on the effect of isothermal heat treatment at temperatures from 390 to 750 F. Most of the tests were made on a steel with 0.4 carbon, 1.4 silicon and 1.1% chromium, but some results were obtained on other structural and tool steels.

At tensile strengths from about 200,000 to 242,000 psi., the isothermally treated specimens showed considerably higher impact values than did conventionally quenched and tempered samples. This superiority was retained at low temperatures. With the most favorable isothermal treatment, there was also an improvement in the notched tensile strength, elongation and reduction of area. When the higher temperatures was used for the isothermal treatment, however, the yield point was appreciably lower than in the fully quenched steel. An attempt to produce the improved impact properties at a lower, more useful, tensile strength by the use of a lower carbon steel proved unsuccessful.

The authors attributed the better toughness of the isothermally treated steel principally to the fact that the conventionally treated steel became temper brittle during tempering, whereas the isothermally treated specimens were held at lower temperatures where temper brittleness was not a factor. A large amount of data were presented in the discussion to disprove this theory. In this discussion it was indicated that the cause was not temper brittleness but rather that the conventionally treated specimens had been tempered in the blue brittle range.

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Applications of Low Pressure Plastic Laminates

Low pressure plastic laminates are relatively young, and there is still much attention being paid to their potential uses as well as to evaluations of their past performance. Recently in a seminar on this subject conducted by The Society of the Plastics Industry the uses to which low pressure laminates are being put in the various government services was discussed.

The Bureau of Ship's development program on low pressure laminates was described by J. Alfers. He said that one of the objectives of their present work was the development of silicones that would retain a high percentage of original strength at continuous temperatures of 390 to 460 F. Molds and molding methods are always a problem, and inexpensive production molds of plastic and metal plated plastic are being tried.

F. H. Behrens in his paper on the use of low pressure laminates for radar and radio antenna housings listed a number of properties of laminating resins which need improvement for these applications. Some of these include increased bonding strength with glass fibers, improved high temperature properties, increased strength, and reduced moisture absorption. In addition he listed a number of properties of laminating filler fibers and sandwich core materials that need further improvement. Most of the current development effort on antenna constructions, he pointed out is confined to the sandwich type of radome wall.

In two papers the use of low pressure plastic laminates in military aircraft was covered. R. T. Schwartz, W. G. Ramke and I. K. Long stated that the principal low pressure laminate applications in Air Force aircraft were (1) radio and radar antenna housings, (2) backing for self-sealing tanks, (3) ducts for cold and hot air, and (4) honeycomb core materials for sandwich construction. They indicated that the problems encountered in the use of low pressure glass fabric base plastic laminates are those of wet strength, exposure to weathering, and rain erosion.

R. Temple listed four major types of applications of low pressure laminates in naval aircraft: (1) Applications where dielectric properties are required and metallic materials cannot be considered, (2) Lightly stressed, non-structural parts where high rigidity with minimum weight is desired, (3) Applications which take advantage of the gunfire resistance of low pressure fiberglas and nylon laminates, (4) Parts of complex contour such as air ducts

which are difficult or uneconomic to fabricate from metal.

W. Stubblebine indicated that low pressure laminates show promise for such low temperature service applications as sleds and skis and other army equipment. Laboratory tests show that laminates do not suffer a great reduction in physical characteristics when exposed to temperatures of −50 F for periods up to four or five weeks.

Finally, A. Lightbody in a paper on the difficulties in low pressure molding, emphasized the need for more standardization of laminating materials. The present solution has been to specify each item in detail, which makes for voluminous requirements. Similar items which have been developed by different manufacturers end up by being specified in entirely different manners. This, of course, leads to confusion of both the manufacturers and the engineers who are responsible for improved designs. However, in a rapidly developing field, standardization is difficult, but it is one step which will do a tremendous amount to boost the use of good low pressure molded items.

Cast Magnesium Alloys Containing Zinc

A concentrated effort is being exerted to develop magnesium-base alloys with improved properties at elevated temperatures. New magnesium alloys containing either cerium or zirconium and having superior tensile properties and resistance to creep at elevated temperatures up to 600 and 700 F have already been described in MATERIALS & METHODS, July, 1948. In a paper by T. E. Leontis appearing in *Metals Technology*, June, 1948, new sand-cast magnesium alloys containing zinc are described. The study includes binary magnesium-zinc alloys containing up to 10% zinc and several ternary and some polynary alloys based on various magnesium-zinc binaries.

The results of tests conducted on these new zinc-containing magnesium alloys show that many of them have resistance to creep at elevated temperatures up to 500 F significantly higher than that of present commercial magnesium alloys, but lower than that of the magnesium-cerium types. The zinc-containing alloys exhibit at least a two-fold superiority at 300 F and a four-fold superiority at 400 F over the commercial

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alloys. In addition, they have high tensile properties at room and elevated temperatures and high conductivity.

This combination of mechanical properties and conductivity indicates that these alloys should be given serious consideration for commercial applications involving exposure to temperatures higher than those to which present commercial magnesium alloys can be taken safely. However, extensive commercial application of these alloys must await further study of such factors as the relative foundry characteristics, including fluidity, porosity tendency, cracking tendency, and grain size in large castings.

Coating Steel with Nickel by a New Chemical Method

A simple method for depositing controlled amounts of nickel on steel by chemical displacement from a hot nickel chloride, boric acid solution is described in a paper by W. A. Wesley and H. R. Copson in the *Journal of The Electrochemical Society*, July, 1948. Deposits up to 30 millionths inch (0.75 micron) thick can be produced in this way.

The bath composition is: nickel chloride, 600 g.p.l.; and boric acid, 30 g.p.l. The pH is specified as 3.5 to 4.5. The rate of nickel deposition increases with temperature, so a hot solution with a temperature of 160 F is used. The thickness of the coating increases with time of immersion; it also depends on other uncontrolled variables such as the surface of the steel.

The nickel deposit obtained by this immersion process is quite porous, and to prevent rusting and staining, it must be rinsed and dried quickly. The deposits can be made compact and adherent by subjecting the coated steel to heat treatment at temperatures between 1200 and 1400 F. This treatment causes diffusion to occur so that the product is really a nickel-iron alloy coating on steel.

Although steel coated in this way develops rust upon weathering the rust that forms is more protective than that on bare steel. It is believed that this nickel coating will serve satisfactorily as a basis for other coatings such as organic finishes, conversion coatings, ceramic enamels, and perhaps for other metallic coatings.

Indications that nickelized steel may have merit as an organic coating base were

obtained in exposure tests in which the temperature was 70 F and the relative humidity was 65%. As little as seven millionths inch of nickel prevented underfilm corrosion of nickelized steel coated with baked, Vinylite type lacquer exposed for 10½ months.

Creep Strength of Light Metal Alloys

Although aluminum and magnesium alloys show some creep at room temperature, and are being used increasingly at higher temperatures where the creep is more pronounced, there has been no general agreement on the method of measuring their creep strength. H. Vosskühler in the March 1948 issue of *Zeitschrift für Metallkunde* (German) reviews the previous work in this field and gives results of stress rupture tests for cast and wrought aluminum and magnesium alloys, tested at 85 and 300 F for periods up to 1000 days. With three exceptions, the stress had become constant before 1000 days, so the real stress rupture strength could be evaluated. The elongation at rupture generally increased with the rupture load, but there were a number of exceptions.

A comparison of these long time stress rupture values with the results of various short time tests showed that the best agreement was obtained with a short time test based on a rate of elongation of 10×10^{-4} %/hr in the 25th to the 35th hr. This corresponds to the standard German short time creep test for steel. Almost as good a correlation was obtained with a rate of elongation of 5×10^{-4} %/hr in the 150th to the 200th hr. The final recommendation is to use the latter test for future work until sufficient additional data are available to prove the reliability of the former, shorter test.

Case Hardening Tools with a New Cyanide Paste

The Russians have developed a new method for cyaniding tools with the use of a paste. A description of the method appears in *The Engineers' Digest*, May, 1948, as taken from *Vestnik Machinostroenia*.

In this method the tool to be treated is

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covered with about a ¼ in. thick layer of the special paste. After the paste has dried, the tool is packed in a box and covered with iron filings and then put in the furnace. The paste is composed of 50 powdered charcoal, 25 sodium chloride, and 25% potassium cyanide. These constituents are mixed and water added to give the paste a water content of 15%. The treatment in the furnace is carried out at 1435 to 1510 F for 2 hr. After the furnace treatment the tool is quenched in water.

The process can be applied to both plain carbon and alloy steel tools. In one instance, the method was used for cyaniding 0.8% carbon steel. In this case the steel was held at 1510 F for 3 hr. After quenching, all test pieces were tempered, the temperatures ranging from 390 to 930 F. One of the test pieces was allowed to cool in the box. The Rockwell "C" hardness ranged from 30 up to 62 depending on the tempering temperature.

In practice this cyaniding method is applied to tool steels with 0.85 to 0.95 carbon, 4.0 to 4.5 chromium, 8.5 to 9.5 tungsten, and 2.0 to 2.6% vanadium.

Projection Welding of Metal Fasteners

Although projection welding is not a particularly new process, it has only come into its own in recent years. In a paper ("Modern Projection Welding") presented at the semi-annual meeting of the *American Society of Mechanical Engineers* in June, R. A. Reich ably described the characteristics and capabilities of this welding method relative to its use in attaching fasteners to metal products.

Projection welding is a form of resistance welding in which the welding operation is localized at projections or embossments on the part. The method is particularly suited to attaching fasteners. Reich pointed out that in the welding of fasteners it is important to set up the correct material specifications. Many materials may be suitable for projection welding but are difficult or impossible to upset and coldwork. The following materials are well suited in both respects: low carbon steel (carbon 0.20% max.), naval brass, Monel, and stainless steel (18:8). Many dissimilar metals can be welded; all the materials listed above as being suitable for projection welded fasteners may be welded using any combination of these materials.

In designing the actual fastener for pro-

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jection welding, it is important to consider its function. All other factors are secondary, such as weldability and appearance, but it is also imperative that the item be designed for economic production. In respect to surface finish, the optimum welds are always made on products furnished in bright finish, free of scale or other foreign materials.

New Aluminum Alloy Sheet

At a recent meeting of the Detroit Section of the Society of Automotive Engineers, F. W. Lynch and J. F. Saut in discussing the expanding use of aluminum in automobiles described in detail several aluminum alloy sheet forms developed by Reynolds Metals Co.

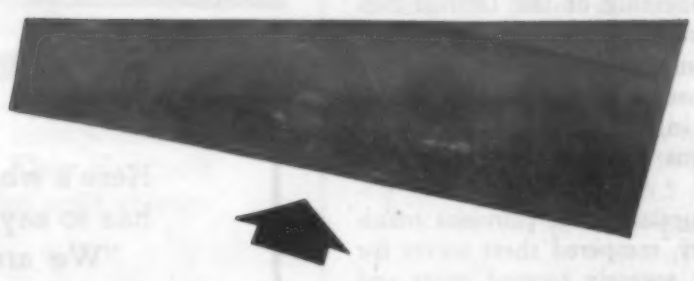
Although annealed sheet provides maximum workability, tempered sheet serves for many drawn or severely formed parts and provides improved strength in the final part. One type of aluminum sheet, designated A. S. No. 1, provides the highest strength-cost ratio. In its various tempers, it finds most use in those applications requiring the best combination of workability, strength, and price. Another type, A. S. No. 2, is primarily a deep drawing material. When used in the fully annealed temper, it meets the requirements of the most severe draws.

Mill-embossed aluminum sheet offers desirable characteristics for applications requiring combinations of attractive appearance, strength, stiffness, and low initial cost. The embossed patterns hide scratches and other signs of wear. And the gage-for-gage replacement of steel sheet becomes feasible since the embossing affords a structural reinforcing effect that provides increased sectional rigidity and strength.

It is to the fabricator's advantage in many cases to use aluminum coils rather than flat sheets because of the one to two cent per pound differential in price. In those cases where circular blanks are used for given press operations, it becomes more economical to purchase circles directly from the mill, thereby avoiding blanking operations and the disposal of scrap. One side bright aluminum sheet can also be used to advantage in many applications. It has been possible to reduce the cost of applying buffed or scratch brushed mechanical finishes on parts if the one side bright sheet is used.

This Peels

This Doesn't



This is a handkerchief test on a sample of regular galvanized sheet steel. The zinc flaked badly at the corner and along the bend at the top. It cannot be drawn or formed severely without exposing bare steel.

These mill-run samples of two zinc-coated sheets *look* much alike, but there is a *big difference*. Look at the photo of another sample on the right.

In this same handkerchief test ARMCO ZINCGRIP is folded over itself. Note that the edge of the bend is just as smooth as the flat parts. Unlike regular galvanized sheet steel, the special zinc coating on ARMCO ZINCGRIP doesn't flake or peel when it is drawn or formed.

Besides this superior zinc-holding advantage for fabricated products, ZINCGRIP possesses 15 to 45% *greater atmospheric corrosion resistance* than the same weights of coatings on regular galvanized sheets. This is the record of ARMCO ZINCGRIP in exposure tests made in various kinds of atmosphere.

For example, after six years in a mild industrial atmosphere yellow rust appeared on all regular galvanized sheet specimens with a 1-ounce coating. There was no indication of rust on *any* ZINCGRIP samples, including those with a 1-ounce coating.

OTHER SPECIAL STEELS

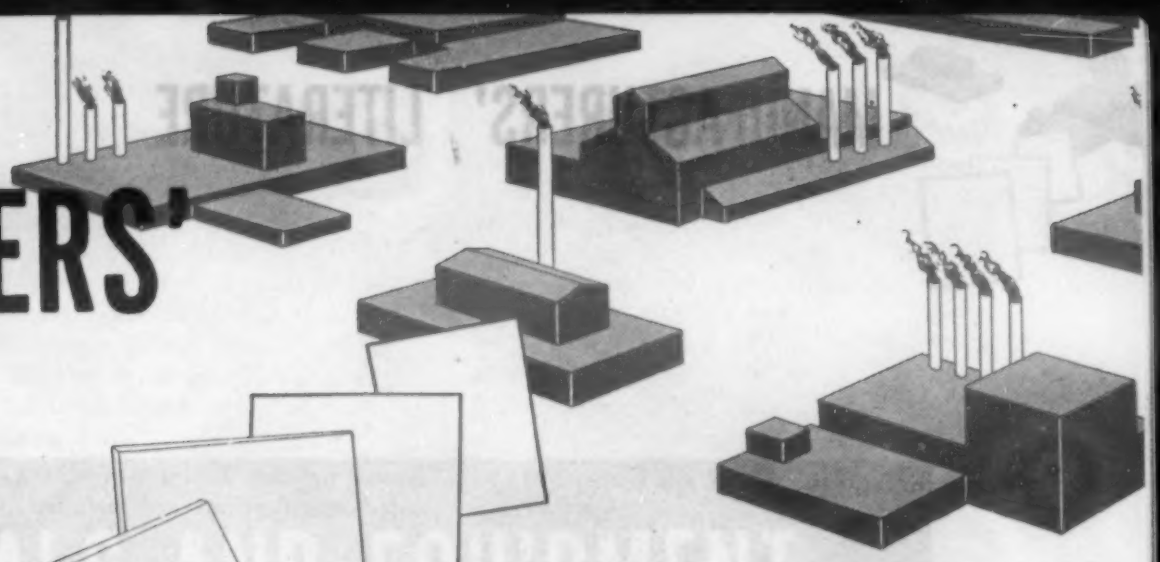
ZINCGRIP is only one of Armco's Special-Purpose Steels. Others include Stainless sheets, strip, plates, bars and wire, PAINTGRIP, ALUMINIZED Steel.

Perhaps some of these Special-Purpose Steels can be applied profitably to your products. Our metallurgists will be glad to work with you. Just address Armco Steel Corporation, 448 Curtis Street, Middletown, Ohio.

ARMCO

ARMCO ZINCGRIP

MANUFACTURERS' LITERATURE



Materials

Iron and Steel

High Temperature Tube Steels. A new edition of a condensed chart of B & W Croloys giving technical data on high temperature steels for alloy tubes and pipe has been released by the Babcock & Wilcox Co. (1)

Stress Calculation. Typical examples of the application of formulas and charts for computing maximum stresses in angles, ribbed plates, and shear resistant webs containing cut outs are presented in an 8-page bulletin, No. 27, and its 20-page supplement, published by the Meehanite Metal Corp. (2)

Nonferrous Metals

Corrosion Resisting Alloys. This 8-page, illustrated bulletin, No. 114, discusses two new Durco products—Chlorimet 2 and Chlorimet 3, consisting of nickel-molybdenum and nickel-molybdenum-chromium alloys respectively—for use in corrosion resistance. The Duriron Co., Inc. (3)

Spot Welding Aluminum Alloys. All phases of the spot welding of aluminum alloys, including surface preparation, equipment, and techniques and testing of spot welds, plus specification charts and numerous diagrams and illustrations, are included in this 36-page bulletin just released by P. R. Mallory & Co., Inc. (4)

Parts and Forms

Precision Investment Casting. Many interesting examples of parts produced by the Microcast process of precision investment casting are described and illustrated in a new 16-page bulletin just released by the Microcast Div. of Austenal Laboratories, Inc. (5)

Zinc Die Castings. A new exclusive process for producing mass quantities of small zinc die castings quickly and automatically is discussed by the Gries Reproducer Corp. in their 4-page, illustrated bulletin. Several informative and valuable charts and tables are included. (6)

Nonferrous and Stainless Steel Fastenings. This 32-page, illustrated catalog includes specifications, packaging data and prices of over 5000 various bolts, nuts, screws, washers, rivets, and accessories made from brass, naval bronze, silicon bronze, Monel metal and stainless steel by the H. M. Harper Co. (7)

Flexible Shafting. Complete data on flexible shafting in improved machine design for remote control and power transmission of fractional or integral horse-power are presented by the Stow Manufacturing Co. in an attractive, 32-page, illustrated catalog, No. 441. (8)

Stainless Piping Systems. The Taylor Forge & Pipe Works has issued a new 4-page bulletin, No. 483, which describes and illustrates their new type fittings and flanges, available in Stainless 304, 347, 316 and other materials. Prices are included. (9)

All-Metal Flexible Tubing. Detailed specifications of a complete line of Titeflex all-metal flexible tubing that withstands pressure, temperature, vacuum, vibration, and the destructive action of various liquids and gases are included in this revised, 24-page, illustrated bulletin, No. 113, released by Titeflex, Inc. (10)

Plastics

Hard Rubber and Plastics. This 60-page, illustrated handbook interestingly presents complete technical data on all grades of Ace hard rubber and plastics produced by the American Hard Rubber Co. (11)

Plastic Molding. The unsurpassed facilities of the Chicago Molded Products Corp., producers of molds and plastic molded parts, are profusely illustrated and described in an attractive, 16-page bulletin, No. 163. (12)

Phenolic Molding Compounds. Complete data regarding the manufacture, use, methods of molding and selection of a variety of phenolic molding compounds produced by Durez Plastics & Chemicals, Inc. are presented in a new, 16-page, illustrated bulletin. An easily-read chart outlining physical and chemical properties, and suggested applications are included. (13)

Injection Molded and Extruded Plastics. The facilities of the Elmer E. Mills Corp. for producing injection molded and extruded plastics, their complete line of thermoplastics, and the many applications of these plastics are all interestingly described and illustrated in an attractive, 48-page catalog. A detailed plastics properties chart is also included. (14)

Nonmetallics

Plastics. A variety of successful applications of Bakelite and Vinylite plastic materials are described and illustrated in an attractive, 8-page bulletin just issued by Bakelite Corp. (15)

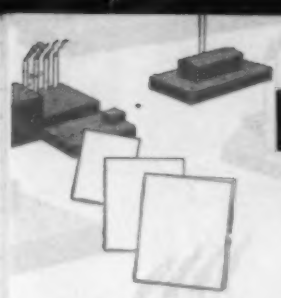
Silicone Mold Release Agents. General properties of a variety of DC silicone mold release agents, as well as major applications of these agents in the fields of lubricating tire molds and curing bags, and in the lubrication of mechanical rubber goods, floor tile and plastics are featured in a 16-page, illustrated bulletin available from the Dow Corning Corp. (16)

Nylon-Covered Ropes. The many advantages and typical applications of nylon-covered wire ropes, which resist fatigue, rust and corrosion and is abrasion-resistant, are listed in this 8-page, illustrated, pocket-size folder, just released by Rochester Ropes, Inc. (17)

Methods and Equipment

Heat Treating

Salt Bath Heat Treating. The first issue of a new house organ, *Salt Bath Tips and Trends,* published by the Ajax Electric Co., consists of short, illustrated articles on the subject of better heat treating and proc-



MANUFACTURERS' LITERATURE

essing through the use of salt baths. (18)

Welding and Joining

Resistance Welding Electrodes and Alloys. A revised, 24-page catalog, No. 68C, describes and illustrates a complete line of resistance welding electrodes and alloys produced by Ampco Metal, Inc. Detailed specifications are included. (19)

Nonferrous and Stainless Steel Fastenings. This 32-page, illustrated catalog includes specifications, packaging data and prices of over 5000 various bolts, nuts, screws, washers, rivets, and accessories made from brass, naval bronze, silicon bronze, Monel metal and stainless steel by the H. M. Harper Co. (20)

Arc Welding Guide. An illustrated, pocket-size booklet filled with useful welding information on the characteristics of various welding arcs, type of joints, welding symbols, four essentials of proper welding procedures, etc. is offered by the Hobart Brothers Co. (21)

Spot Welding Aluminum Alloys. All phases of the spot welding of aluminum alloys, including surface preparations, equipment, and techniques and testing of spot welds, plus specification charts and numerous diagrams and illustrations, are included in this 36-page bulletin just released by P. R. Mallory & Co., Inc. (22)

Hard Surfacing Electrodes. A complete line of hard surfacing electrodes, each of which provides a weld metal deposit whose particular properties are suited to definite welding applications and are outstanding in their field, is presented by the Page Steel & Wire Div. of the American Chain & Cable Co., Inc., in their new bulletin, No. DH-45. (23)

Adhesive Operation Data Sheet. Step-by-step recording of the necessary information for the proper study and analysis of labeling, sealing and fabricating adhesive operations is possible through the use of an adhesive operation data sheet supplied by Paisley Products, Inc. (24)

Rocker Arm Welders. A new, improved line of air-operated, standard 30- and 50-kva. rocker arm welders for high production spot welding of a wide range of light-to-medium-duty applications is described and illustrated in a 4-page bulletin, No. 702, available from the Progressive Welder Co. Performance data and specifications are included. (25)

Press Welders. Various types of ENB press welders, designed to meet present-day requirements for rugged but precise spot and projection welding service with long life and low maintenance, are described and illustrated in an 8-page bulletin, No. 3-123, issued by the Taylor-Winfield Corp. Detailed specifications are included. (26)

Forging and Forming

Hydraulic Straightening Press. The Colonial Broach Co. has just released a revised bulletin, No. PS-48, covering its expanded line of hydraulic presses for straightening both rough and finished work. (27)

Silicone Mold Release Agents. General properties of a variety of DC silicone mold release agents, as well as major applications of these agents in the fields of lubricating tire molds and curing bags, and in the lubrication of mechanical rubber goods, floor tile and plastics are featured in a 16-page, illustrated bulletin available from the Dow Corning Corp. (28)

Metal-Working Press. The Hydraulic Press Manufacturing Co. has published a 4-page, illustrated reprint on the use of its H-P-M Fastraverse all-hydraulic, self-contained metal working press in the plant of one of its customers. (29)

Machining

Automatic Balancing of Grinding Wheels. The advantages of equipping a Cincinnati Filmatic grinding machine with the new automatic wheel balancing mechanism, which balances grinding wheels automatically in a few seconds, are presented in a 4-page, illustrated bulletin, No. G-583, offered by Cincinnati Grinders, Inc. (30)

Cutting Fluid. The many advantages of using Cimcool, a new, multi-purpose cutting fluid that combines friction reduction and cooling capacity in a degree never before attained, are listed in a novel, 4-page folder just released by the Cimcool Div. of the Cincinnati Milling Machine Co. (31)

Self-Opening Die Heads. A variety of H & G general purpose, self-opening die heads, which use hobbed chasers that are famous for accuracy, are described and illustrated in an 8-page bulletin, No. 5, issued by the Eastern Machine Screw Corp. (32)

Coolant Tank and Filter Unit. Instructions for installation and operation of the Hoffman Model 1-3V coolant tank and filter unit on micromatic Models 100-200 hydrohoners are given by the U. S. Hoffman Machinery Corp. in a 4-page, illustrated bulletin, No. A-519. (33)

Automatic Chucking Machines. Three types of work rotating, four-spindle, automatic chucking machines, Models 475, 49 and 412, are profusely illustrated and described in a 12-page bulletin offered by the New Britain-Gridley Machine Div. of the New Britain Machine Co. Detailed specifications are included. (34)

Chatterless Countersinks, Reamers, Etc. Specifications and prices of a variety of both standard and heavy-duty type chatterless countersinks, ball seat, taper and drill reamers, and ball nose drills are featured in this 4-page, illustrated bulletin, No. 16-C, issued by Severance Tool Industries, Inc. (35)

Diamond Tools. The development of Sample-Marshall diamond-mounted tools, wheels and files for light cutting and semi-finishing operations is interestingly presented by Triangle Equipment Co., Inc. in their 6-page, illustrated folder. Prices are included. (36)

Cleaning and Finishing

Metal Washing Machines. A new automatic machine that washes, rinses, dries, deburrs and tumbles a wide variety of metal parts, stampings and screw machine products produced by the American Machine & Solvents Co., is described and illustrated in a 4-page bulletin. Specifications are included. (37)

Coatings for Petroleum Refineries. Six types of Amercoat vinyl coatings for obtaining corrosion control in petroleum refining are listed and a detailed chart of recommended uses included in this 4-page, illustrated bulletin, No. PRB-48, just released by the Amercoat Div. of the American Pipe & Construction Co. (38)

Copper-Oxide Rectifiers and Controls. A complete line of automatically and manually controlled copper-oxide rectifiers and controls that meet the exacting requirements for electroplating, anodizing, electrocleaning, electropolishing and other electrolytic processes is presented by the General Electric Co. in their 28-page, illustrated bulletin, No. 21-47. Specifications are included. (39)

Nickel Plating. The basic essentials of electroplating and a detailed discussion on nickel plating practices are presented by the International Nickel Co., Inc. in a helpful, 44-page, illustrated catalog. (40)

Acid- and Alkali-Proof Resin Coating. This 4-page bulletin discusses the properties and applications of Nukemite No. 40, a protective and decorative coating for use in chemical and mechanical operating conditions that require extreme corrosion and abrasion resistance. Nukem Products Corp. (41)

Selenium Rectifiers. A complete line of selenium rectifiers for electroplaters, electrotypers, anodizers and all other industrial users of a.c. to d.c. power conversion equipment is described and illustrated in an 8-page bulletin offered by the Richardson-Allen Corp. A wiring diagram showing the necessary hook-up information is included. (42)

Mechanical Finishing and Deburring. Complete data on Roto-Finish, the engineered process for mechanical finishing and deburring, are presented by the Sturgis Products Co. in a new, 16-page, illustrated bulletin. (43)

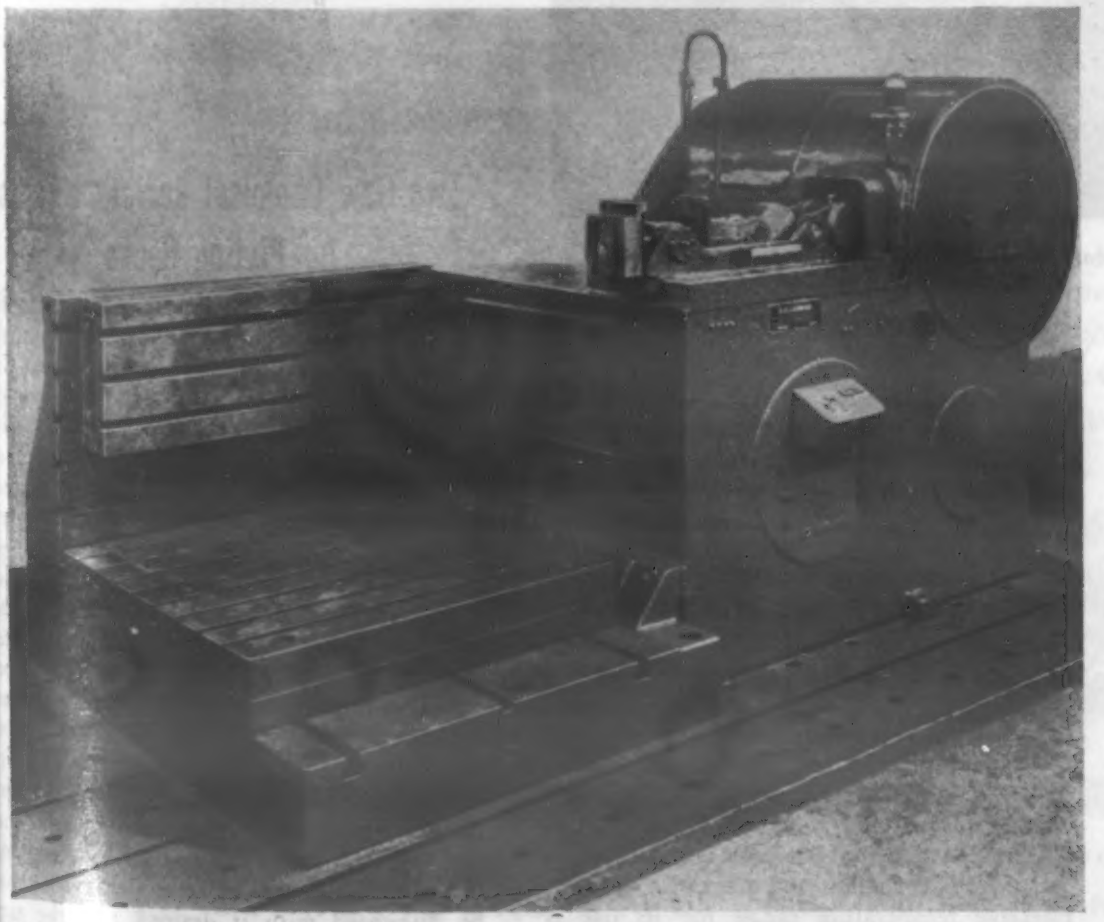
New MATERIALS AND EQUIPMENT

Fatigue Testing Machine Simulates Service Conditions on Large Parts

To meet the growing demand for testing equipment capable of loading full-sized machine and structural parts or assemblies under simulated service conditions, the *Baldwin Locomotive Works*, Testing Equipment Div., Philadelphia 42, has developed a line of fatigue testing machines on which the stroke can be varied from zero to 8 in. Loads up to 10,000 lb. can be applied directly in tension and compression, and with simple fixtures torsional fatigue loading can be applied.

One of these machines is of the constant force stroking type. It is a flexible, crank-stroking type in which the stroke is adjusted by a planetary gear system with an independent motor that maintains constant load by varying automatically the distance of a spindle from the center of rotation. The spindle serves as a crank in activating the connecting rod and crosshead that applies fatigue stress to the part under test. Large parts and assemblies up to approximately 5 by 5 by 5 ft. can be subjected to fatigue loading in this machine. It can be operated up to 250 cycles per min. Another machine with a maximum speed of 500 cycles per min. has been built, and a machine with a range of 0 to 1000 cycles per min. has been designed.

Automatic equipment for controlling and indicating load, and recording changes in stroke are contained in a separate cabinet. The load is controlled by means of a light sensitive cell aimed at the end position reached by the luminous spot on the scale. If the test specimen starts to weaken and the luminous spot fails to reach the light cell, the motor of the stroke change mechanism of the machine is automatically actuated to increase the length of stroke until the load is restored to its original magnitude.



Fatigue tests of parts up to 5 by 5 by 5 ft. can be made on this 10,000 lb. capacity testing machine.

Cold-Molding Powder Available in All Colors

Cold-molding plastic powder which requires no pre-heating, no pre-forming, no after-baking or finishing is now being manufactured by *Myler Plastics Corp.*, 92 Bishop St., Jersey City 4, N. J. It is a free-flowing powder available in colors. The standard colors are black, red, buff, light gray, yellow, light blue, and light green.

The physical properties of the powder can be varied by formula to adapt it to specific product uses. It can be pressed on either rotary, single-stroke or hydraulic presses. Parts can be turned out at speeds as high as 30,000 small units per press per hr. it is claimed. Some typical uses of the material are for bottle caps, checkers, toy parts, fuse plugs and insulators.

Liquid Wax Serves as Lubricant for Impact Extrusion

A new liquid wax for use as a lubricant in the manufacture of metal items by the impact extrusion process has been developed by the *S. C. Johnson & Son, Inc.*, Racine, Wis.

In impact extrusion a waxed metal slug is placed in a die and struck a single, hard blow with a punch, causing the metal to flow out of the die and shoot up the sides of the punch to form a perfect tube. Considerable heat is generated in the process, and the need for complete freedom of flow requires an efficient and rugged lubricant. This new wax is said to meet these requirements. It remains in place under the heat and does not dissipate itself—thus cutting the number of rejects due to scoring caused by imperfect lubrication.

The wax can be applied to slugs before extrusion by dipping or tumbling. It provides a dry finish that is easy to handle and sanitary, and will not turn rancid.

Aluminum slugs being tumbled to receive a coating of liquid wax before being extruded.

Two New Cleaners Can Be Used Alone or Together

Two new metal cleaners, said to be effective individually or in combination for cleaning a variety of metals and alloys, are being marketed by *Calgon, Inc.*, Pittsburgh.

One of these cleaners, No. 21, is a dry granular alkaline detergent for spray-cleaning in metal-washing machines. In addition, it can be used in combination with the other cleaner, for immersion cleaning in dip tanks, and for heavy-duty spray cleaning.

Although designed primarily for cleaning of steel products or parts, it is also suited for a variety of other metals and alloys. It spray-cleans aluminum, for example, without etching its surface; in long immersion or dip-type cleaning of aluminum a slight etching may occur. It is said to be good as a pre-cleaner when the metal surface is to be phosphate-coated, or otherwise treated. Effective temperature range for its use is 140 to 180 F.

The other cleaner is a white, creamy emulsion of an organic solvent in a [illegible] tively small amount of water. It [illegible] disperses when added to the cleaning [illegible] It is especially recommended for use [illegible] combined solution with Cleaner No. [illegible] for immersion cleaning or especially [illegible] cult spray-cleaning. This mixture or [illegible] bination of the two cleaners is said to [illegible] vide the advantages of alkaline cleaner [illegible] those of an organic solvent.

This emulsion cleaner, when used alone or in combination with an alkaline cleaner is said to be easily rinsed from the metal surface with either hot or cold water, leaving no solvent or other film. This is particularly important when the cleaning is to be followed by certain types of treatment such as electroplating. Temperature range recommended is 140 to 160 F.

Stripping Compound Removes Paints at Room Temperature

A new, cold solvent material for [illegible] moving paint and similar finishes from metal surfaces, has been announced by *Oakite Products, Inc.*, 132H Thames St., New York 6.

According to the manufacturer it is effective in removing baking japans, wrinkle finishes, nitrocellulose lacquers, and synthetics such as alkyds, phenolics, ureas and vinyls from such metals as steel, galvanized iron, die castings, aluminum, copper and brass, with no attack on the metal.

Designed for use at room temperature, the solvent may be applied by tank immersion method or by swabbing or brushing. This is followed by hot pressure-rinse to remove loosened paint particles.

Two New Chemical Resistant Tapes for Plating Racks

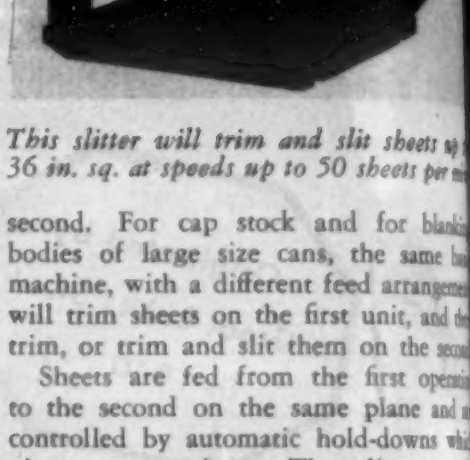
A new synthetic resin in tape form for insulating plating racks, has been announced by the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J. It is effective as a stop-off in hard chromium and other plating solutions and is said to chemically resist all cleaning, pickling and plating solutions commonly used. It provides uniform coverage and is said to be clean and safe to use.

Another synthetic resinous tape, which resists chemical attack, aging, and insulates electrically, has been announced by United Chromium, Inc., 51 East 42 St., New York 17. The tape is designed especially for use by the electroplating industry as a coating for racks or for stop-off purposes. The tape is said to resist plating baths, hot cleaners, pickling solutions, electrocleaners and anodizing. Wrappings are anchored by cementing down only ends of tape. Cementing may be dispensed with if desired, and the tape fused into one continuous coating by baking at 275 to 300 F for 15 to 30 min.

Slitter Designed for Plain Iron or Tin Sheets

Plain iron or tin sheets having a maximum thickness of approximately 0.017 can be handled on the new slitter developed by *Lima-Hamilton Corp.*, 60 E. 42 St., New York 17. Operating speed of the machine is 50 sheets a min. or slower, depending upon requirements.

This duplex slitter will trim and slit sheets up to 36 in. square into strips on the first unit, and then automatically trim and slit the strips into body blanks on



This slitter will trim and slit sheets up to 36 in. sq. at speeds up to 50 sheets per min.

second. For cap stock and for blanking bodies of large size cans, the same basic machine, with a different feed arrangement, will trim sheets on the first unit, and then trim, or trim and slit them on the second.

Sheets are fed from the first operation to the second on the same plane and are controlled by automatic hold-downs which give exact registry. The slitter can be arranged for plain material or lithographed sheets, and can be hand-fed or operated in conjunction with an automatic sheet feeder.

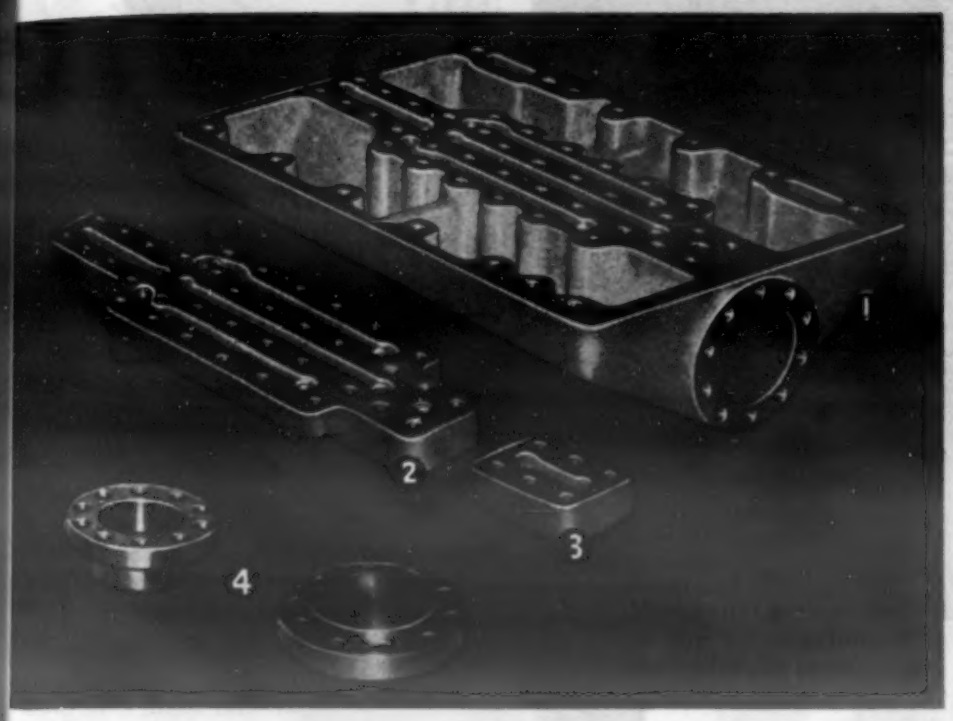
Floor space occupied by the machine measures 132 in. by 90 in., front to back by right to left, including grinding attachment. Approximate net weight of the machine, including the grinding attachment, is 7,270 lb. The unit stands approximately 40 in. high, from floor to top of feed table.

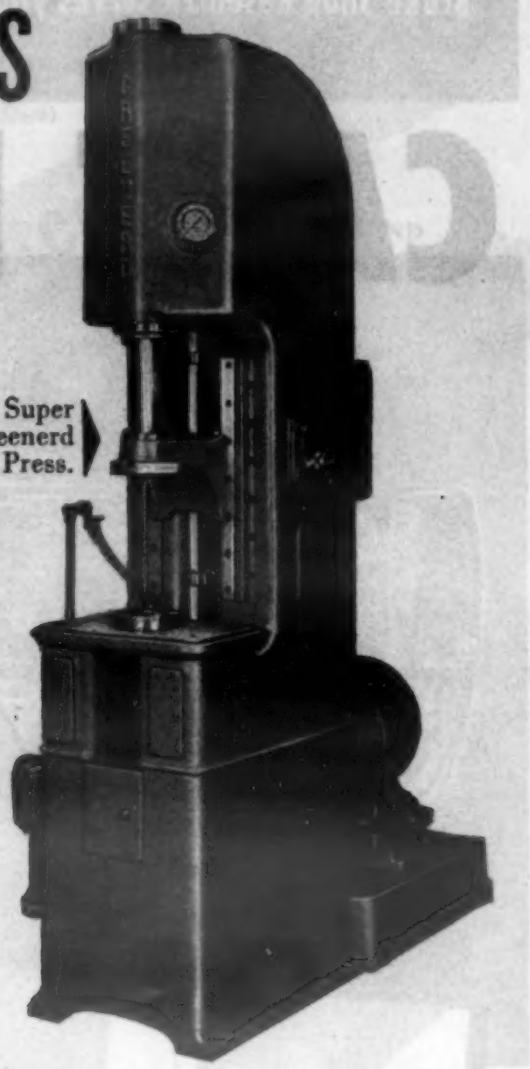
New Portable Sheet Metal Brakes Have Open End Bars

Portable sheet metal brakes, featuring detachable open end bars and adjustable finger assemblies, are now being manufactured by *Webb Machine & Tool Co.*, Coraopolis, Pa. The new brakes bend sheets (steel, aluminum, copper, or lead) up to 18 gage, depending on brake model and folding arm used. Clamping bar operates easily and adjusts automatically for all gages.

On Model W-48, open end bar has 37 in. working width face; 12¼ in. width each end of bar. On Model W-30, open end bar has 27 in. working width face; 8¼ in. width each end of bar. Sliding folding fingers are available in seven sizes. Standard bars have working widths of 31 in. or 43 in., depending on model. Folding bars can be removed for bends impossible to make on fixed bars.

"For Close-Grained Pressure Tightness Rigidity MEEHANITE® ere the answer"





New Super G Line, Greenerd Hydraulic Press.

THE GREENERD ARBOR PRESS COMPANY, Nashua, New Hampshire, make this statement concerning their reasons for the specification of Meehanite castings used in the construction of their new Super G Line high speed hydraulic presses. Specification of the material was made after extensive testing and in service this high production press must maintain rigid accuracy and minimum deflection.

Of particular importance is the Meehanite main frame which must provide sufficient rigidity to resist overload and also not distort under fatigue. In operation at a full speed of 300 inches per minute and pressure of six tons, the frame shows but very slight deflection—practically none.

Parts subjected to oil pressure must be pressure tight and free from any leaking or seepage whatsoever.

In addition to the frame the following Meehanite castings are also used:

1. Main Head which includes cylinder and cored oil ports
2. Manifold
3. Manifold cap
4. Bottom and top caps
5. Base or oil pump

This Greenerd press represents another example of the successful combination of advanced design thinking with maximum properties of high quality materials. Meehanite metallurgical and production controls are enabling hundreds of equipment manufacturers to improve quality and increase production efficiency through the utilization of dependable engineering characteristics.

For further information write for Bulletin No. 28 "7 Questions and Answers about Meehanite Castings."

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry Inc.	Providence, R. I.
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rossdale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey
Washington Machinery & Supply Co.	Spokane, Washington
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
U. S. Challenge Co.	Centerville, Iowa and Batavia, Illinois

"This advertisement sponsored by foundries listed above."

MEEHANITE®

PERSHING SQUARE BUILDING • NEW ROCHELLE, N. Y.

● A new "ventilated" contact wheel f abrasive belt polishing is being marke by the *Jackson Buff Corp.*, Long Island C N. Y. This new contact wheel has b designed for contour or flat work on st less or carbon steel stampings, aluminu brass, die castings and forgings. The wh is said to offer maximum resilience, yield readily to pressure, and springing back i shape quickly for the next pass. Availab in 6- to 16-in. dia. in standard sections ½-in. face.

New Welder Combines D.C. and A.C. in Single Unit

Both d.c. and a.c. arc welding can performed with the new combination we er offered by *John A. Kern Co.*, 224 Loomis St., Chicago 7. The arc is set f d.c. or a.c. operation by setting two switch and a hand lever.

For d.c. operation, the machine u rectifier tubes installed in a flexible mou ing to supply direct current. Welds light gage metals, including stainless st are said to be uniformly good and the is easy to strike and hold, even with el trodes as small as 1/32 in. Metal as li as 32 gage can be welded without burn

Quick change-over for either a.c. or d operation is possible with this combinat welding machine.

through or appreciably altering the gr structure. Straight or reversed polar electrodes may be used.

The machine's a.c. welding characteris are said to include smooth, instant start and stable arc action and quiet operati Inert gas shielded arc welding performan with a.c. operation has been found sat factory when a high frequency current introduced into the circuit.

New Thermometer Element Has High Stability

A new bonded wire resistance thermometer element, said to have high stability, accuracy and rapid response has been developed by *Ruge-de Forest,* 76 Massachusetts Ave., Cambridge 39, Mass. Essentially, it consists of a grid of fine nickel wire bonded into a paper-thin Bakelite wafer. Bakelite cement is used to attach the wafer to the surface whose temperature is to be measured. The element operates with full accuracy in continuous service from –40 to 300 F.

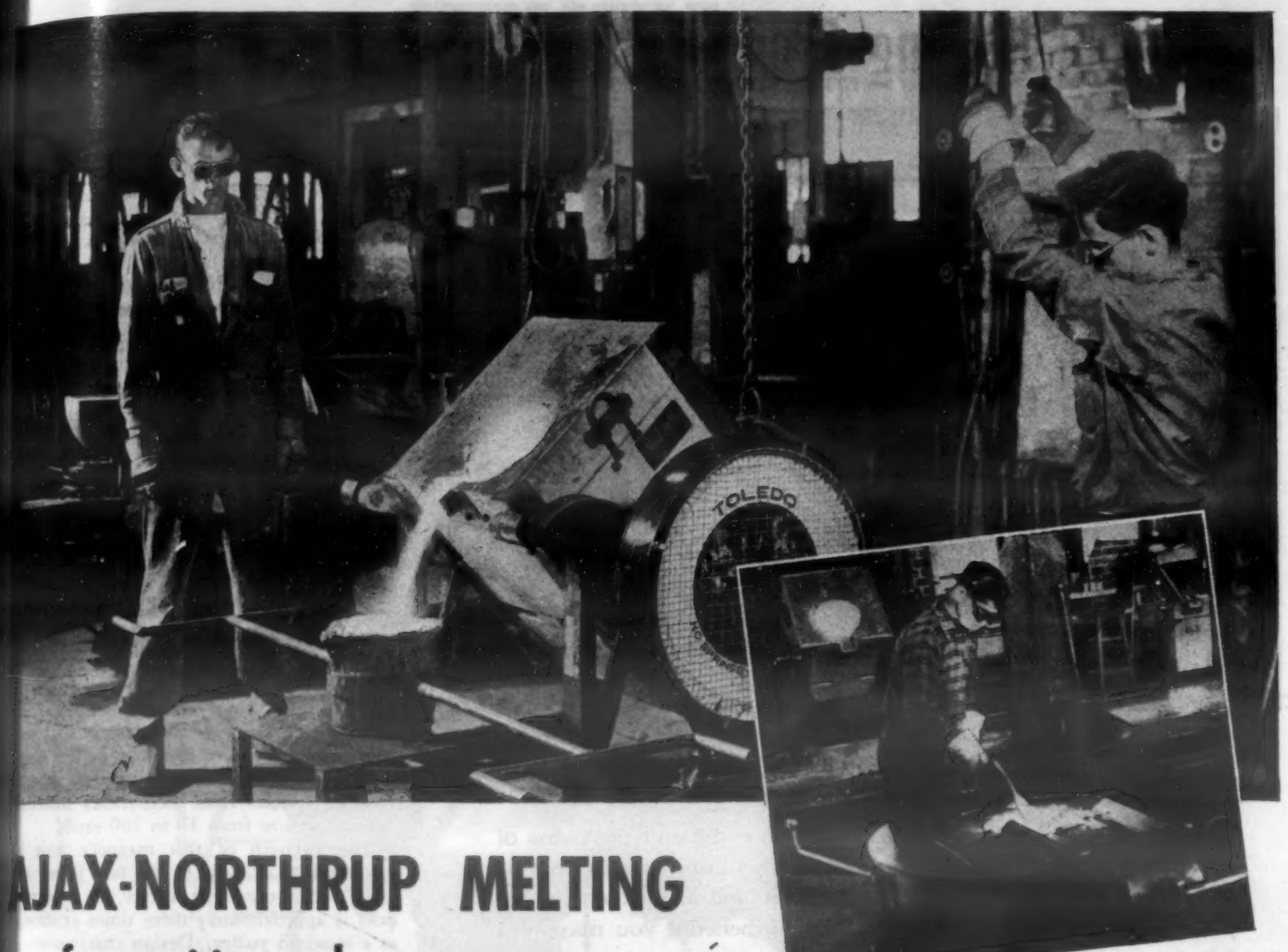
The physical and electrical characteristics of these elements are such that they are useful for measurement or control in industrial processes and laboratory investigations as well as for temperature-sensing elements in instrument applications such as the telemetering of flight data. They are also well suited to the precise measurement of temperatures on rotating shafts, propellers, etc., since they can be used in conjunction with slip rings, and application that cannot be satisfied by thermocouples and other conventional devices.

One of the new bonded wire thermometer elements shown in use on an engine head.

Instrument Controls Temperature by Regulating Power Flow

An electronic temperature control instrument which regulates power flow into electrically heated devices according to temperature variations has been announced by *Scientific Glass Apparatus Co., Inc.,* Bloomfield, N. J. It may be preset to reach and maintain any desired temperature within the range of 32 to 930 F. The instrument is fully portable.

It employs an iron-constantan thermocouple, placed within the apparatus to be controlled, to produce an electrical current variable with temperature changes. This tiny current or signal is amplified in an electronic circuit to actuate a 3-kwa. sealed-in-glass mercury relay. The relay remains



AJAX-NORTHRUP MELTING

for precision and centrifugal casting DOUBLES YIELD!

Free on request—Ajax technical bulletins covering any melting or heating problem. Just tell us what metal and production rates, we'll rush information to you.

Here's another case where fast, easy-to-control melting with Ajax-Northrup furnaces has teamed up with centrifugal casting—this time leading to greatly increased strength in fine-grained alloy cast iron—and yielding two times as many finished castings per ton of metal melted than was possible with previous gray iron practice.

And in the inset photo, the same kind of success is routine for precision castings. Yes, in centrifugal casting, in lost-wax processes, in precision casting of all kinds, Ajax-Northrup's inherent ability to hit composition and pouring temperatures "on the nose"—at high speed—has reduced "impossible" specifications to mere routine in case after case.

If speed and close melting control without contamination or oxidation are important to you, these success stories can probably be matched in your plant.

SINCE 1916

AJAX NORTHRUP

HEATING & MELTING

AJAX ELECTROTHERMIC CORPORATION

AJAX PARK, TRENTON 5, N. J.

Associate Companies

THE AJAX METAL COMPANY • AJAX ELECTRIC FURNACE CORPORATION

AJAX ELECTRIC COMPANY, INC. • AJAX ENGINEERING CORPORATION

closed until the selected temperature is reached. The circuit is then broken until the temperature begins to drop, and the cycle is repeated.

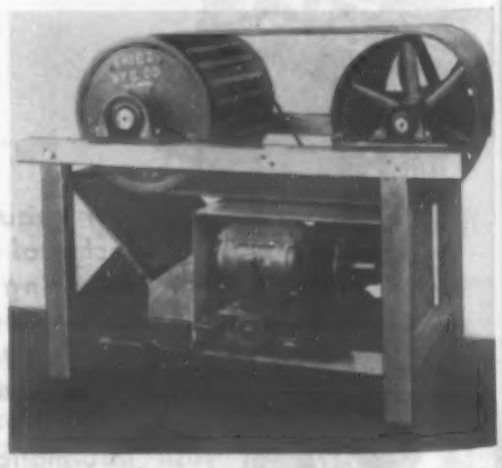
The dial for temperature control reads directly in degrees Centigrade. The inner dial is calibrated in single degrees from 0 to 100, while the outer dial covers 100 degrees for each graduation. The temperature control may be used wherever a temperature variation may be the actuating force. As examples, the control of ovens, hot plates, water baths, heated molds, and other similar heating devices are suggested.

Magnetic Pulley Concentrates Strength at Surface

A new type of magnetic pulley produced by the *Eriez Manufacturing Co.*, 137 E. 12th, Erie, Pa., is non-electric. It was developed to remove fine iron or less magnetic particles and afford automatic separation of ferrous from nonferrous material ranging in size from 10 to 200 mesh.

The strength of this magnetic unit is concentrated in close to the face plate. At 1 in. from the pulley's surface, the magnetic field is approximately three times as strong as a standard pulley. Design characteristics, as well as new Alnico material, are said to account for additional strength.

The effective cleaning surface has been increased by narrowing the air-gaps and increasing the number of pole plates. This provides more major areas of magnetic concentration. The unit is adaptable for removing fines from such materials as talcs, powders, chemicals, salts, glass sands, ball clays, granulated slag, rubber and any other substances requiring a high degree of purification. The effective cleaning range



This magnetic pulley, requiring no electricity, removes fine iron from a variety of materials.

varies, depending on the size of material being processed and the type of separation desired.

Designed for use as a head pulley in belt conveying systems, the unit is available in 18- and 24-in. dia. and in belt widths ranging from 12 in. to 60 in.

New Resistance Welding Equipment

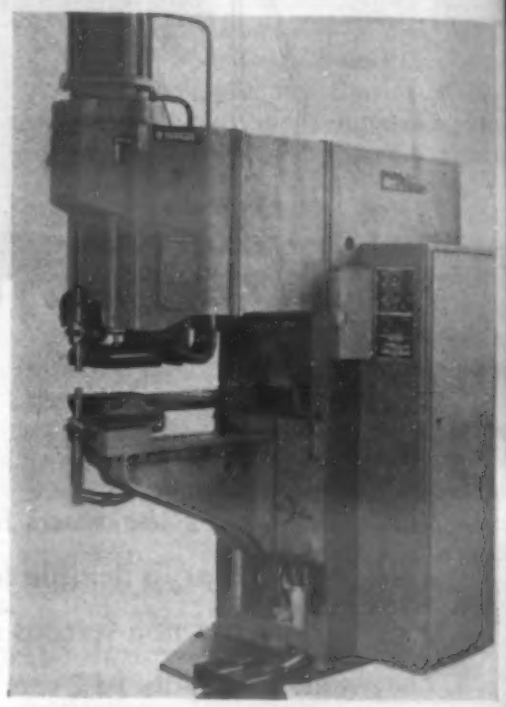
Holder for Spot Welder Tips

A newly designed water-cooled ejector type holder for spot welder tips has been announced by *Ampco Metal, Inc.*, Milwaukee 4, Wis. Welder tips are ejected with a light tap on the head.

A feature of the new holder is a leakproof and replaceable water seal of Sirvene rubber. The head is of an aluminum-bronze alloy; the ejector sleeve is stainless steel and the barrel is constructed of a high conductivity alloy. Water connections are set at an angle with sufficient clearance to permit the use of shut-off couplings or extra heavy hose.

Resistance Welders

Three-phase balanced power, giving power factor of 95% at reduced power demand is featured in the new resistance welders in production at *Taylor-Winfield Corp.*, Warren, Ohio. The welder, called Tri-Phase, is said to make possible more



This Tri-Phase welder is designed to overcome power supply difficulties.

production or heavier welding with present power installations.

Other advantages claimed are: reduced electrode wear and pickup; closer spot spacing and less sensitivity to work thicknesses; welding circuit permits a greater range of shapes and sizes of work to be welded, especially in deep throated welders; welding currents are essentially constant when magnetic work or fixtures are moved into work area.

The welder is suitable for a variety of materials including low carbon steel, stainless steel, aluminum alloys, magnesium alloys, Monel, Inconel and brass alloys.

Four Point Projection Welder

A multiple projection welder was recently designed and built for the *Pressed Steel Car Co.*, Domestic Appliance Div., by *Sciaky Bros., Inc.*, 4915 W. 67 St., Chicago 38. This machine replaces an operation

formerly accomplished by a spot welder, and has two important advantages: (1) Production rate was increased from 80 to 360 units per hr., and (2) The type of weld assured a perfect indentation free surface on the exposed side of the panel.

This machine is rated 100 kva at 50% duty cycle, and performs the welding of 4 clips simultaneously on 4 sizes of stove panels. The electrode cylinders are hydraulically operated and adjustable to the 4 sizes of stove panels. Considering loading, welding, and unloading time, it is capable of producing, under good conditions, 400 units in one 50-min. hr.

Cut-Off Machine Designed to Use "Flexible" Type Wheels

The new swing frame cut-off machine, designed to take full advantage of the new "flexible" type cut-off wheels, is especially recommended by the manufacturer, *Fox Grinders, Inc.*, Pittsburgh, for removing sprues and risers from bronze, aluminum and iron castings.

Having full maneuverability through 180 deg., the machine is particularly intended to be used with the "flexible" cut-off wheels now on the market. The wheels operate at a peripheral speed of 15,500 ft. per min., and cuts can be made to conform more or less closely to the contour of the casting. Because of the high speed and maneuverability, large risers can be cut by using sawing action, thus maintaining minimum contact area, reducing power consumption, and lessening wheel wear.

The new swing frame cut-off machine in action.

The cut-off machine is powered by a 7½-h.p. totally enclosed fan-colored ball bearing motor. It accommodates wheels 16 in. by 5/32 in. by 1 in. and weighs approximately 400 lb.

New Contact Metal Minimizes Sticking or Welding

A new electrical contact metal said to have the desirable properties of fine silver plus a substantially higher "no-weld" current value has been announced by *Fansteel Metallurgical Corp.*, North Chicago, Ill.

Laboratory tests over an extended period show that the contact surface resistance of the metal, known as Fasaloy 99, is no higher than that of fine silver, even when the contacts are subjected to high temperatures or hydrogen sulfide atmospheres. Tests reported by the manufacturer also show that contacts of the alloy will make and break resistance load circuits of as high as 25% more current than fine silver, without failure due to sticking or welding.

The contact metal appears to be well suited for uses where relatively low operating pressures and high temperatures are encountered, and where circuits of relatively high amperage are made and broken. Such conditions are commonly encountered in electric irons, ranges, toasters and other heating devices, and in many industrial appliances as well.

Electric Furnace Has Temperature Range from 300 to 2000 F

Temperatures in the range from 2000 F to as low as 300 F are possible in a new model electric box furnace being produced by *Cooley Electric Manufacturing Corp.*, 38 S. Shelby St., Indianapolis, Ind. This range permits not only hardening and other high temperature work, but also low temperature applications such as tempering or drawing of steel and non-ferrous heat treating.

The furnace has an 8 by 6 by 14 in. chamber; it is suitable for tool and die work, production heat treating of small parts, running pilot lots, emergency repairs, industrial and laboratory testing, and other work within its range where controlled heating is required.

This furnace features a simplified vertical lift door having exterior mechanism and counterweights. The vertical sliding door conserves heat when charging small parts since only a limited portion of the chamber need be exposed. Power capacity of the furnace is 4650 w. The furnace heats from cold to 2000 F in 1½ hr.

Accurate temperature control down to as low as 300 F is claimed. Used in combination with an indicating-controlling pyrometer, this unit permits meeting critical temperature requirements. Power input may be adjusted to balance furnace heat losses. Further, a modifier prevents the furnace from running to destructive temperatures in the event of pyrometer failure.

This furnace is suited for heat treating

(Continued on page 140)

GRAY IRON FOUNDERS' SOCIETY, INC.

33 PUBLIC SQUARE • CLEVELAND 13, OHIO • PHONE PROSPECT 8480

A Report to the Leaders
of American Industry

Gentlemen:

Recent developments in the Gray Iron Foundry industry have been so noteworthy as to merit calling some of them to your attention.

First, technical progress has been very great, making gray irons available for many new uses and applications. For example, cast irons are now being made with tensile strengths up to 60,000 p.s.i. and even higher. An almost infinite variety of gray irons have been developed to meet specific requirements for components of greater strength, rigidity, damping capacity, machinability, etc.

Through advances in metallurgical and design engineering, better gray iron products are being made with actually less weight and bulk. More and more, foundries are adopting modern methods and are in a position to attract and hold better men.

Gray Iron Founders' Society, whose 600 members represent upwards of 75 per cent of the industry's tonnage, has launched a program of education and advancement that will be of far reaching importance.

The unmatched combination of engineering properties which modern gray irons offer, suggest broader consideration by every possible user.

Respectfully yours,

Howard A. Stockwell

Howard A. Stockwell
President

Because of its wide temperature range this electric box furnace has a variety of applications.

of stainless and air hardening steels, which have hardening temperatures well above those normally employed for heat treating alloy and carbon steels. It may be used also for normalizing, annealing, carburizing and hardening in the range from 1200 to 2000 F.

● Two improved diamond penetrators for Rockwell testing have been designed by *Clark Instrument, Inc.*, 944 Free Press Bldg., Detroit 26. The "C" diamond penetrator fits all makes of hardness testers for standard Rockwell testing, and the "S" diamond penetrator fits all machines for superficial Rockwell testing.

Weld Metal from New Electrodes Resist Wear

Two electrodes of the coated tubular type for depositing abrasion resisting surfaces of weld metal have been added to the line of hard facing electrodes by the *Lincoln Electric Co.*, Cleveland 1. Tubular electrodes are steel tubes containing the hard surfacing alloy in a concentrated form. The alloy is deposited into the molten crater where it is either bonded into a tough iron alloy matrix or alloyed by the heat of the arc with the base metal to create the final hard surfacing alloy.

One of the electrodes, called Tungweld-C, is a tubular, light coated electrode which contains in the tube coarse particles of tungsten carbide. The particles are deposited by the arc in the weld crater and as the weld solidifies are held in a tough iron alloy matrix. When the edge of the deposit is subjected to abrasive wear, the iron alloy and the base metal wear away exposing the teeth-like particles of tungsten carbide, thus producing a self-sharpening edge.

This electrode is recommended for use

YALE

now offers a CARTRIDGE HEATER*

that, first of all, lasts longer

In the new YALE Cartridge Heater the resistance element is embedded directly into refractory cement, which is then fused. A direct path of heat conductivity is thus provided, from resistor to sheath. This means lower resistor operating temperature, and consequently longer heater life.

But that's not all. When it's YALE heat, it's *uniform* heat. With a YALE made unit there is always

1. **Uniform distribution of the refractory within the sheath for *uniform insulation.***
2. **Accurately centralized location of the resistor—equidistant from the sheath throughout its length—for *uniform heat transfer.***

Prompt shipment on Cartridge Type Heating Units—one of a *complete* YALE line of electric heaters.

Please use coupon below to receive full information on this and other types of YALE *Electric* Heating Units.

*Screw plug type for liquid immersion.
Plain cartridge type for general uses.

YALE *Electric* UNIFORM HEAT

THE BRIGHT SPOT IN ELECTRIC HEATING

TRADE **YALE** MARK

Makers of the famous YALE lines of Locks, Door Closers, Pumps, Hoists, Industrial Trucks and Scales.

THE YALE & TOWNE MANUFACTURING COMPANY
YALE *Electric* HEATING UNIT SALES
Room 1038, Chrysler Bldg., New York 17, N. Y. • Murray Hill 9-6700

Please send catalog with full information on YALE Cartridge Type Heating Units. Our proposed application is described below.

.....

.....

NAME.....

TITLE.....

COMPANY.....

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CITY..... ZONE..... STATE.....

for surfacing earth cutting tools and f facing other tool surfaces to resist seve abrasion.

The second electrode, named Tungwel

This water well drilling cable tool is typical hard surfacing application for th new electrodes.

F, is a shielded arc tubular electrode con taining fine particles of tungsten carbid It is for use on earth cutting tools bu produces a smoother, thinner and sharpe edge than the rough edge of Tungweld-C The tungsten carbide particles are so smal that they will not stick out like teeth as d the coarser particles, and are so close to gether that they are not undermined b the abrasion of a blast of muddy sand.

● A new selenium rectifier for plating gold, silver, chromium, nickel, copper, cad mium, etc. on metals, as well as non-metals is now in production by the *Lewis Electrical Mfg. Co.*, 1943 Walton Ave., New York 53. Some of its features are: variable d.c. voltage (from zero to maximum); workin in tandem (several units can be combined to raise voltage or amperage); and no warm-up period is required.

Noncorrosive and Nonconductive Core Solder

The development of "Resin-Five" core solder has just been announced by the *Kester Solder Co.*, 4201 Wrightwood Ave., Chicago 39. This solder is specifically designed for all types of electrical and electronic soldering, but can be used for general soldering.

"Resin-Five" is noncorrosive, nonconductive, virtually odorless, and will easily solder zinc, brass, nickel silver, nickel-plate, copper, and ferrous alloys.

Kester "Resin-Five" is not a mixture of rosin with another flux, but a resin involving chemical interaction as the anhydride structure of the rosin itself, converting it from a naturally inactive state to an active state, yet preserving its original noncorrosive and electrically physical character.

A BUYING GUIDE FOR ABRASIVES

ABRASIVE PROBLEM:

Is the correct abrasive available?

ANSWER BY

CARBORUNDUM

TRADE MARK

The Carborundum Company produces the only complete line of abrasives under one trade mark. With industrial techniques utilizing a wider variety of different abrasive products, it is only logical to turn to The Carborundum Company as the one primary source of all abrasive needs.

The specialized service of experienced representatives is available to recommend, impartially, the best abrasive products for specific requirements. Product quality is known and highly regarded. Satisfaction is assured. Responsibility is definitely fixed and undivided.

In part, this helps explain the increasing preference for abrasives by CARBORUNDUM. The Carborundum Company, Niagara Falls, N. Y.

A Good Rule for Good Grinding...CALL IN

CARBORUNDUM

TRADE MARK

BONDED ABRASIVES

COATED ABRASIVES

ABRASIVE GRAINS AND FINISHING COMPOUNDS

Specialized wheels by CARBORUNDUM for thread grinding

Diamond wheels to meet stiffer technical needs.

"Carborundum" is a registered trademark which indicates manufacture by The Carborundum Company

Cool-cutting GREEN GRIT wheels for cemented carbide

A coated abrasive for every sanding and finishing condition.

All standard shapes are supplied in grinding wheels by CARBORUNDUM

Wet Abrasive Cutting Machine Will Handle 6 in. Solid Stock

A new semi-automatic wet abrasive cutting machine is in production at the *Campbell Machine Div., American Chain & Cable Co., Inc.*, Bridgeport, Conn. It consists of an oscillating swing frame, a work feeding and holding mechanism, a coolant system and a hydraulic work clamping and wheel feed unit.

The abrasive wheel is automatically fed through the work and upon completion of cut, is automatically returned to starting position. The return of the wheel is controlled in such a manner as to compensate for wheel wear. The handwheel operated feed carriage is incorporated, which also acts as a length gage bar for cut-off pieces and also serves as an ejector for the cut-off parts. The bar being cut is firmly clamped on both sides of the cut-off wheel while cut is being made. A hydraulic gripper is incorporated in the feed carriage and is timed with the clamps at the wheel. This machine will cut 6 in. dia. solid stock or any shape that can be contained in a 6 in. circle.

● The *Air Reduction Sales Co.*, 60 E. 42 St., New York 17, has announced the availability of a new silicon bronze electrode. According to the manufacturer these electrodes may be used for the welding of silicon bronze base metal, copper and for joining galvanized iron and silicon bronze to steel. It is believed that this new electrode will find wide acceptance in the manufacture of chemical and food processing equipment, sewer disposal equipment and hot water tanks.

Drill Grinder Has Two Grinding Heads

A new line of twist drill grinding machines in sizes suitable for sharpening drills from #52 to 4 in. has been announced by the *Gallmeyer and Livingston Co.*, Grand Rapids, Mich. The new machine is designed to sharpen standard 2, 3, and 4 flute drills of either straight shank or taper shank type at the standard 59 deg. angle. The small drills are ground dry on one side of the machine, the large drills wet on the opposite side.

The drill holder proper is designed to take 2, 3, and 4 flute drills of either straight shank or taper shank type, and the only adjustment necessary when changing from the sharpening of a small 2-flute drill to the grinding of a 3-flute drill of a larger diameter is to slide the tailstock so that it compensates for the difference in length.

The drill holders are equipped with a rectangular lip rest which supports the lip

of the drill. This lip rest is reversible from side to side, or from top to bottom, should it become worn in one position.

A diamond truing device for dressing the face of the grinding wheel makes it

Drills being ground on the two heads of the drill grinder.

possible to automatically maintain proper relationship between the holder and the face of the grinding wheel. It is not necessary to swing the holder out of position when dressing the wheel. As the diamond is fed into the wheel for dressing, the holder is automatically moved in to compensate for such amount as may be removed from the face of the grinding wheel by the diamond dresser.

New Combination Alkali-Emulsion Cleaner

A new type, low priced, combination alkali-emulsion cleaner for pressure washing equipment that will remove oils and tallow based drawing compounds is announced by the *Northwest Chemical Co.*, 9310 Roselawn Ave., Detroit 4, Mich.

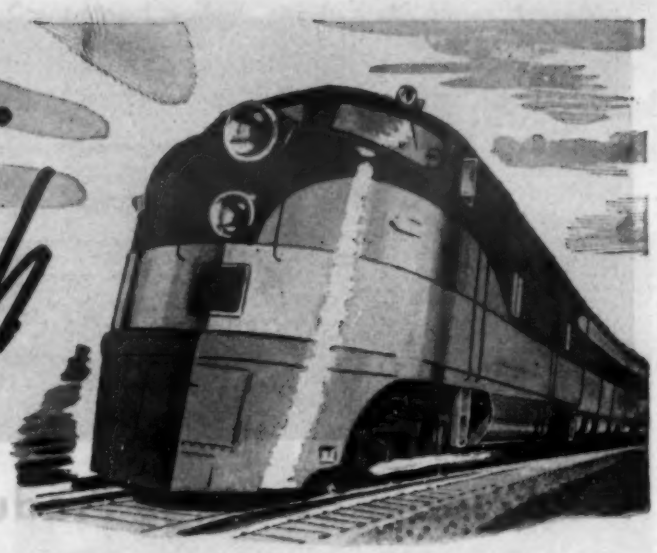
Northwest Metal Cleaner SC-9 aids in controlling foam and the formation of rust, and is particularly adapted to general washing machine use, prior to bonderizing and painting, and as a precleaner prior to plating.

Tube Bending Press Doubles the Number of Bending Sequences

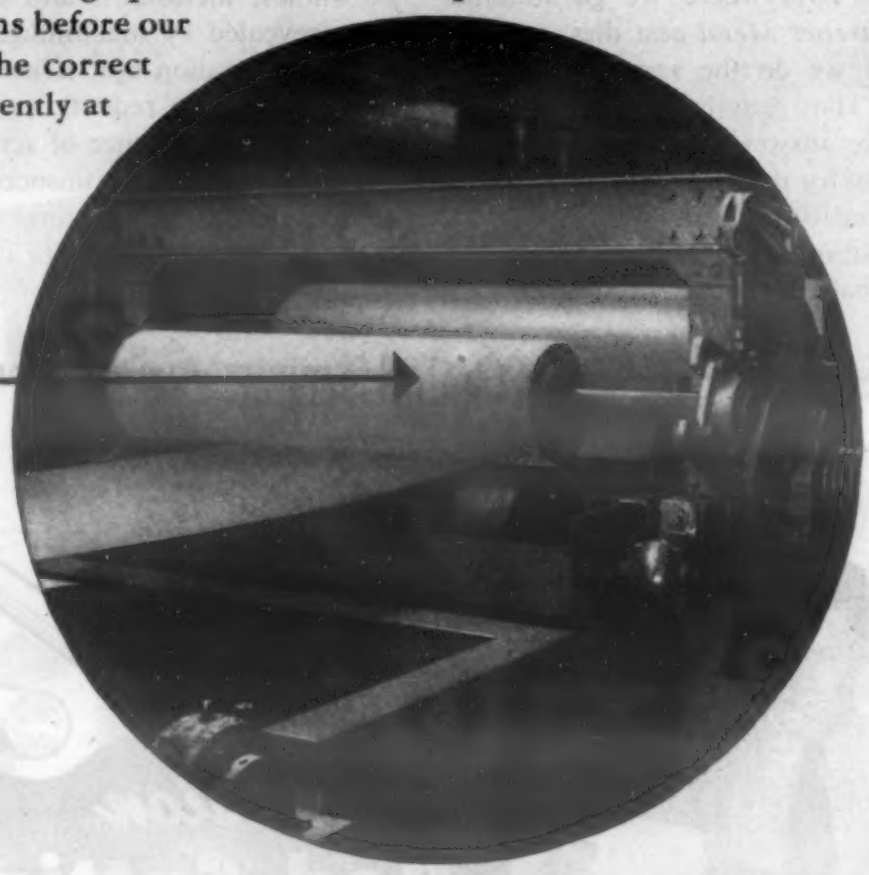
A new hydraulic tube-bending press has been announced by *Elmes Engineering Works, American Steel Foundries,* 1002 Fulton St., Chicago 7. This new press allows any number of sequences up to the maximum of twelve, with adjustable bending depth and automatic reset. This, together with a choice of four bending radii, gives a selection of any or all of 48 possible bending variations for forming exhaust

READY FOR HER DEBUT . . .

thanks to Pittsburgh



HERE'S WHAT HAPPENED:—Today's streamlined trains need big tonnages of high ...shed metal. One of the nation's leading strip producers ran into trouble with his ...shes—brushes which burnish strip rolling, under high pressure, at 40 miles per hour. ...e many other industrialists, he put his problems before our ...illed brush engineers. Pittsburgh selected the correct ...rfect balanced brush that would work efficiently at ... required speed.



This is the Pittsburgh brush that did the job!

The brush had to be stiff enough and ...ugh enough to resist abrasion; yet ...ft enough to improve the surface ...ture. Thus another industrial brush ...oblem was solved by Pittsburgh! ...ou too, can always depend on Pitts...rgh to solve your brush problems. ...he efficiency and performance of ...ittsburgh Power-Driven Brushes are ...ested and proved day after day by ...rip producers all over the country.

There's a Brush by Pittsburgh for Every Industrial Use—

GLASS	AUTOMOBILE	TIRE & RETREADING
STEEL	RUBBER	SHOE MANUFACTURING
PLASTICS	PAPER	& REPAIRING

In the complete Pittsburgh line are brushes of all ...pes, including "Perfect Balance" sections, wheels and ...semblies. Uni-fill scratch brushes as well as paint and ...er maintenance brushes. Consult the Pittsburgh en...neering representative. He will gladly work with you ...n developing any type of power-driven brushes to ...eet your particular finishing specifications.

Use only Power-Driven Brushes By Pittsburgh—it pays

You can depend on Brushes by Pittsburgh to meet your particular finishing requirements. Perfect balance, top performance, enduring economy and a minimum of lost time in changeovers–Pittsburgh Power-Driven Brushes are specifically engineered to do your job right.

FREE!

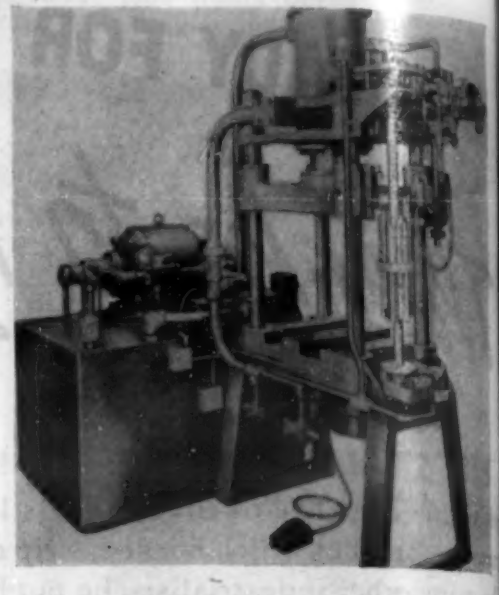
Steel rule and depth gauge, 6", complete with pocket clip, and atttractive leather case. Yours for the asking . . . write Pittsburgh Plate Glass Company, Dept. W-4, Baltimore 29, Md.

Power Driven **BRUSHES**

BRUSHES · PAINT · GLASS · CHEMICALS · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

pipes, frames, furniture tubing, and similar products on a mass production basis. Press capacity is 20 tons.



This new tube bending machine can be set up quickly, making it feasible for experimental runs as well as production.

In line with each cushion are two bending noses, each having a different radius. A new type indexing device controls the sequence and depth of bends. After sequence has been completed, the index automatically resets to starting position. Foot treadle control operates the press cycle.

● A new liquid masking compound for masking of windows, chrome trim, accessories etc., prior to painting, has been announced by the *Automotive and Aviation Service Div., Detrex Corp.*, Box 501, Detroit 32. This new compound is applied with a brush or spray gun. It dries to form a soft continuous white coating to protect the surface against paint overspray.

Electric Radiant Heaters Use Long Wave Length Radiation

All-metal electric radiant heaters using almost the entire infrared band have been developed by *Edwin L. Wiegand Co.*, 7525 Thomas Blvd., Pittsburgh 8. These heaters are designed for drying, baking, preheating and dehydrating where a longer-wave infrared heat source is desired.

The electric radiant heater has a high-temperature enclosed type heating element mounted in an extruded aluminum body with a reflector sheet of polished Alzaked aluminum. Tongued and grooved sides and two sliding captive bolts facilitate fabrication of heater sections into various working patterns. The heating elements are mounted at the focus of a parabolic re-

Conventional welder circuit (left) shows irregular current flow, arc "black-outs," and unbalance (d-c component) in the alternations above and below the straight zero line.

The built-in stability of G-E Type WP Inert-Arc welders produces the uniform "balanced-wave" current (right below).

HERE'S WHY

YOU CAN WELD ALUMINUM BETTER

...with INERT-ARC WELDERS

Originally designed *specifically* for welding aluminum without flux and with minimized radio interference, these Type WP Inert-Arc welders have been made even better than ever with the incorporation of G-E Idlematic control.

YOU WILL FIND IT EASIER TO OPERATE

Simply touch the electrode to the work, and you're off to a good weld. Idlematic control makes it as easy as that!

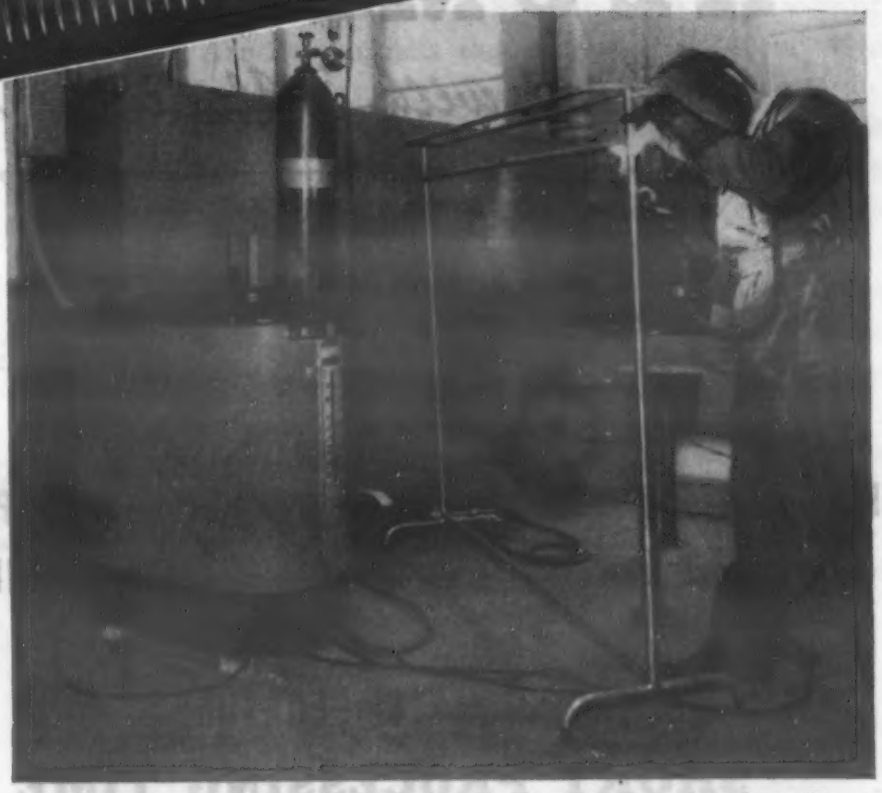
YOU CAN MAKE CLEAN STARTS

Easy striking and reduced tungsten consumption of the Idlematic Inert-Arc welder will save you time and money. Clean welds mean fewer rejects.

YOU GET AN ADDED SAFETY FEATURE

Accidental discomfort to the operator, from the open-circuit voltage of the welding transformer, has been eliminated.

Want to know more about savings in gas consumption—increased welding speed—better bead contour? See your G-E Arc-welding Distributor—or mail the coupon below.



In welding this sturdy, tubular, aluminum coat rack, the starts have been made neatly and easily, producing fine-looking, flux-free beads—thanks to the Idlematic control and balanced design of the G-E Inert-Arc welder.

Section B672–99
Apparatus Dept., General Electric Co.
Schenectady 5, N. Y.

Yes, mail me bulletin GEA-4930 describing the G-E Inert-Arc process and equipment, addressed to me as follows:

Company.....
Name.....
Address.....
City.....
State.....

"A-C or D-C . . . there's G-E Arc-welding Equipment for Every Application!"

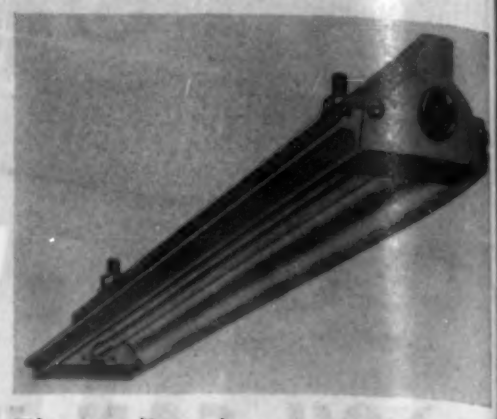
ARC WELDERS • ELECTRODES • ACCESSORIES

GENERAL ELECTRIC

672-99

flecting surface; they operate at temperatures of 1000 to 1400 F, depending upon wattage of the heating element.

The interlocking and sliding bolt features permit flexibility in fabricating groups of heaters into patterns — arcs, circles,



These radiant heaters are designed for drying, baking and preheating applications.

squares, etc. Adjacent sections can be interlocked on a plane or, by means of hinge-acting joints, can be rotated up to 25 deg. Three standard body lengths are 25, 31 and 47 in., with respective heated lengths of elements 17, 23, and 39 in. are available.

Vinyl Plasticizer is Compatible with Variety of Resins

Availability of a new vinyl plasticizer of the phosphate type has been announced by *Monsanto Chemical Co.*, St. Louis 4, Mo. Known as Santicizer 141, it is designed as a primary plasticizer for polyvinyl chloride and polyvinyl acetate film, sheet or molded articles.

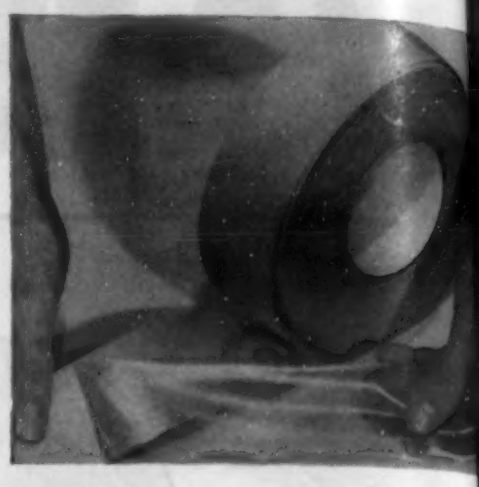
The new plasticizer is compatible with a variety of resins, in addition to polyvinyl chloride. These include cellulose nitrate, cellulose acetate-butyrate, ethyl cellulose, polymethyl methacrylate, polystyrene and polyvinyl butyral resins. In polyvinyl chloride, it possesses low volatility and imparts good low-temperature flexibility, excellent solvent resistance, and flame retardance. Suggested uses are curtains, table cloths, handbags and floor tile. Laboratory test data of the manufacturer indicate that the plasticizer is free of any systemic toxicity and is non-irritating to human beings.

New Adhesive Provides Strong Metal-to-Metal Bond

An adhesive that provides a metal-to-metal bond is being marketed by *Minnesota Mining & Manufacturing Co.*, 900 Fauquier Ave., St. Paul, Minn. It is transparent, roughly resembles cellophane in appearance and is provided in rolls like tape and is not tacky to the touch. It is

100% adhesive, with no supporting material in the film.

The film is placed between units to be bonded and is cured by simultaneous application of heat and pressure. A temperature of 300 to 500 F for 5 to 60 min. at



This adhesive is not tacky to touch and can be used in bonding metal and nonmetallic

a pressure of 25 to 100 psi. are used, both varying with the type of bond desired.

Manufacturer's tests showed shear strengths to 3500 psi. in bonding 0.063 in. aluminum Alclad to itself. In bonding the same metal to fibre, wood and plastic surfaces, the nonmetallic materials delaminated at 880, 1770 and 2800 psi. respectively. The adhesive did not fail.

The adhesive is said to be inert in water, oils and most solvents and preparation of surfaces requires only conventional cleaning.

Silicone Rubber Products

The *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio, has just announced that gaskets, diaphragms, grommets, washers, seals and packings, and numerous other extruded and molded shapes and products are now available made from silicone rubber. This new material has been developed specifically to meet the critical demands of many high and low temperature applications in which resiliency is of primary importance.

In addition to being suitable for dielectric applications, silicone rubber parts are resistant to permanent compression even under extreme heat, and withstand the effects of prolonged weathering. They have excellent water repellency, which enables them to maintain high surface resistivity under moisture condensing conditions, and are also resistant to lubricating oils and some chemicals.

Silicone rubber products are expected to have wide applicational value in such products as: electric irons, industrial ovens, steam generators, gas cylinders, oil burners, jet and conventional aircraft engines, electrical heating equipment, electric motors, transformers, and die casting machines.

Timer Control

A new Model MSW timer control has been announced by the *Miller Electric Manufacturing Co.* of Appleton, Wis., for use with their Model MSW portable spot welder.

This timer control is a NEMA Type 1A, 60 cycle, adjustable from 3 to 120 cycles (1/20 sec. to 2 sec.), and operates on either 110 v. or 220 v. The cycle to be used is selected by adjusting a control on the case. A numbered indicator disk, geared to this control, indicates the cycles in use.

The timer has been designed to mount on the wall, or on a work bench.

Honing Machine Designed for Flat Surfaces

The manufacture of a new line of machines for finishing flat surfaces has been announced by *Micromatic Hone Corp.*, 8100 Schoolcraft Ave., Detroit. In the present series of six models there will be two types of machines both using either bonded or loose abrasives. One will finish flat surfaces regardless of the shape or size of the part. The other machine will finish two opposite sides of the parts simultaneously within 0.0001 in. for parallelism.

One or more parts may be honed simultaneously on these high production machines.

One or many parts may be processed simultaneously on these machines. The surfaces produced will be optically flat within one light-band and can be held to a finish of one microinch R.M.S. or less if desired. Any material from soft copper, to quartz, or Nitroalloy, may be finished on this equipment.

(More News on page 158)

Improved distribution for STOODY Hard-Facing Alloys

TO PROVIDE more effective coverage, better service and additional technical assistance in the use of hard-facing alloys, Stoody Company announces certain changes in its distributor organization. The accompanying list contains the names of principal distributors throughout the United States and Canada.

IN ADDITION TO THESE DISTRIBUTORS, *local dealers in industrial and agricultural areas handle Stoody products. For the name of your local dealer, write or phone the distributor nearest you.*

STOODY DISTRIBUTORS IN THE UNITED STATES AND CANADA

ALABAMA
Birmingham,
POST WELDING SUPPLY COMPANY

ARKANSAS
Little Rock,
WELDERS SUPPLY COMPANY

CALIFORNIA
Fresno,
VICTOR EQUIPMENT COMPANY
Los Angeles,
VICTOR EQUIPMENT COMPANY
L. J. PADDOCK COMPANY (Los Nietos)
Oakland,
VICTOR EQUIPMENT COMPANY
San Diego,
VICTOR EQUIPMENT COMPANY
San Francisco,
VICTOR EQUIPMENT COMPANY

COLORADO
Craig,
THE DENVER OXYGEN COMPANY
Denver,
THE DENVER OXYGEN COMPANY
WESTERN OXYGEN COMPANY
Durango,
WESTERN OXYGEN COMPANY
Grand Junction,
THE DENVER OXYGEN COMPANY
Pueblo,
WESTERN OXYGEN COMPANY

FLORIDA
Jacksonville,
DUVALL WELDING SUPPLY COMPANY
Miami,
MIAMI WELDING SUPPLY, INC.
Tampa,
GENERAL ENGINEERING & MACH. CO., INC.

GEORGIA
Atlanta,
PYE-BARKER WELDING SUPPLY COMPANY

ILLINOIS
Chicago,
C. E. PHILLIPS & COMPANY

KANSAS
Hutchinson,
KOPPER SUPPLY CO., INC.

LOUISIANA
Baton Rouge,
LOUISIANA WELDING SUPPLY COMPANY
New Orleans,
GULF WELDING EQUIPMENT CO.
Shreveport,
PEERLESS SUPPLY COMPANY, INC.

MARYLAND
Baltimore,
SOUTHERN OXYGEN COMPANY, INC.
Bladensburg,
SOUTHERN OXYGEN COMPANY, INC.

MICHIGAN
Detroit,
C. E. PHILLIPS & COMPANY

MINNESOTA
Duluth,
W. P. & R. S. MARS COMPANY
Minneapolis,
MINNESOTA WELDING SUPPLY COMPANY
Willmar,
PARSONS WELDING SUPPLY CO., INC.

MISSOURI
Kansas City,
KIRK-WIKLUND & COMPANY

MONTANA
Billings,
MONTANA STEEL & SUPPLY COMPANY
Great Falls,
MONTANA STEEL & SUPPLY COMPANY

NEBRASKA
Omaha,
THE BALBACH COMPANY
OMAHA WELDING COMPANY

NEW MEXICO
Albuquerque,
INDUSTRIAL SUPPLY COMPANY

NORTH CAROLINA
Asheville,
SOUTHERN OXYGEN COMPANY, INC.
Greensboro,
SOUTHERN OXYGEN COMPANY, INC.

NORTH DAKOTA
Minot,
SKOGLUND WELDING & SUPPLY COMPANY

OHIO
Cleveland,
SCOTT-TARBELL, INC.
Youngstown,
SCOTT-TARBELL, INC.

OKLAHOMA
Oklahoma City,
CLOVIS GEE SUPPLY COMPANY

OREGON
Portland,
J. E. HASELTINE & CO.

PENNSYLVANIA
Philadelphia,
SOUTHERN OXYGEN COMPANY, INC.
Pittsburgh,
ORRWELD, INC.
Wilkes Barre,
COMMERCIAL GAS CORPORATION
York,
SOUTHERN OXYGEN COMPANY, INC.

SOUTH DAKOTA
Aberdeen,
PARSONS WELDING SUPPLY CO.

TENNESSEE
Kingsport,
SOUTHERN OXYGEN COMPANY, INC.
Knoxville,
SOUTHERN OXYGEN COMPANY, INC.
Memphis,
DELTA OXYGEN COMPANY, INC.

TEXAS
Beaumont,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Corpus Christi,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Dallas,
MAGNOLIA AIRCO GAS PRODUCTS CO.
El Paso,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Fort Worth,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Houston,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Kilgore,
BRAMBLETT & ALLEN WELDING SUPPLY
Lubbock,
WEST TEXAS OXYGEN COMPANY
Odessa,
WEST TEXAS OXYGEN COMPANY
San Antonio,
MAGNOLIA AIRCO GAS PRODUCTS CO.
Stamford,
WEST TEXAS OXYGEN COMPANY
Tyler,
BRAMBLETT & ALLEN WELDING SUPPLY
Wichita Falls,
MAGNOLIA AIRCO GAS PRODUCTS CO.

UTAH
Salt Lake City,
WHITMORE OXYGEN COMPANY

VERMONT
Burlington,
GRADY'S WELDING SUPPLY

VIRGINIA
Norfolk,
SOUTHERN OXYGEN COMPANY, INC.
Richmond,
SOUTHERN OXYGEN COMPANY, INC.
Roanoke,
SOUTHERN OXYGEN COMPANY, INC.

WASHINGTON
Seattle,
J. E. HASELTINE & CO.
Spokane,
GIBSON WELDING SUPPLIES

WEST VIRGINIA
Bluefield,
SOUTHERN OXYGEN COMPANY, INC.
Huntington,
SOUTHERN OXYGEN COMPANY, INC.

★ ★ ★

ALBERTA, CANADA
Calgary, Edmonton, Lethbridge,
PRECISION MACHINE & FOUNDRY, LTD

BRITISH COLUMBIA
Vancouver, Victoria, New Westminster,
McLENNAN, McFEELY & PRIOR LIMITED

ONTARIO, CANADA
Toronto,
G. D. PETERS & CO. OF CANADA, LTD.

QUEBEC, CANADA
Montreal,
G. D. PETERS & CO. OF CANADA, LTD.

STOODY COMPANY
1159 WEST SLAUSON AVENUE, WHITTIER, CALIFORNIA

Buffing Compound Produces Color on Metal

A new bar composition for color b carbon steel, stainless steel and chro plate has been developed by the Ha *Van Winkle-Munning Co.*, Matawan, In order to produce a good color o above metals free from cloud or cau necessary that the compound prod very light and soft face on the buff sufficient lubrication to prevent scratc Compositions producing this type of face have very limited cutting ability

The buffing composition has a bi that retains the abrasive on the buff for a greater period of time permitti to do its cutting and does not build heavy waxy face that prevents a high free from casts. It is said to produce a finish on carbon and stainless steels an the same time cuts out imperfections from the cutting down operations. It will rapidly cut and color burned chrom

Low Cost Hydraulic Press for Laboratory or Production Work

A new hand-operated portable hydra press for laboratory or production w has been introduced by *Studebaker Mac Co.*, 1221 South 9th Ave., Maywood, Optional with the unit are electric heated platens for plastics or other ope tions that require temperatures. Hea element is thermostatically controlled even distribution of heat over entire pla

Operation of hand lever produces up

Electrically heated platens are available wit this portable hydraulic press.

8 tons pressure between platens. The u press can be adapted to broaching, asse bling, piercing, oil grooving, riveting, st ing, forming, flanging, staking, forcing small die tryouts.

Base is 10 by 10 in.; height 13 in. hydraulic ram travels 3 in.; platens 5½ by 7 in.; platen openings to user's require ments, 0 to 6 in.; weight 70 lb.

Announcing the New Airco 700 Welding Torch

The Airco 700 is easily converted to handle general shop cutting work by the addition of a cutting attachment.

. . . DESIGNED TO HANDLE 90% OF YOUR WELDING AND BRAZING JOBS

Before designing the new Airco 700 Torch, we asked shop operators and welders what features they wanted in a welding torch. The new "700" incorporates their recommendations and those produced by Airco research engineers. Salient features are:

Wide Operating Range . . . The Airco 700 Torch is available with a wide selection of tips for use on almost any welding job from thin sheet metal up to two inch plate. Equipped with a multi-flame tip, it is unbeatable for silver and aluminum brazing.

Better Flame Control . . . The Airco 700 Torch is available with tip assemblies which range from Nos. 00 thru 10. Each welding tip is assembled with a mixer drilled for that particular size of tip. This means finer flame control . . . there is no sputtering —better welds result.

Low Maintenance Costs . . . The Airco 700 Torch has a head of durable, long-wearing monel metal. This means fewer replacements and also lower maintenance costs because rarely is reseating required.

Perfect Balance . . . The Airco 700 Torch (with a No. 5 tip) weighs only 19½ ounces and is 16½ inches in length. Equipped with 3/16" I.D. hose, the "700" eliminates heavy hose drag, and reduces operator fatigue.

For heavier jobs, Airco also has available a Series 800 Torch which is comparable to the "700" in both appearance and operating characteristics.

If you would like to have either the "700" or "800" demonstrated in your shop . . . or if you desire more information about these torches, address Dept. MA-8414, Air Reduction, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. On West Coast: Air Reduction Pacific Company, San Francisco 4, Calif.

AIRCO

AIR REDUCTION

Offices in all principal cities

Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

News of...

ENGINEERS COMPANIES SOCIETIES

Engineers

William B. Sullivan, who has been credited with having initiated the first American research work in developing high temperature alloys, has rounded out 45 years as a steel executive and new products pioneer. He has retired as manager of alloy sales for Lebanon Steel Foundry, Lebanon, Pa. He is holder of several patents. Before joining Lebanon in 1935 he had served with leading steel castings and allied companies. When with Carpenter Steel Co. he went to Panama to set up tool steel specifications used in construction of the canal. He organized the Michiana Products Corp. in 1928 to make high temperature alloy castings. He has made periodic trips to England, France, Germany and Sweden to keep abreast of foreign techniques. He was chairman of the steel industry's alloy casting group of the National Recovery Administration. In 1933 he was one of the organizers of the Alloy Casting Institute.

Paul Queneau has been made metallurgical engineer, International Nickel Co. of Canada, Ltd. and subsidiaries at New York, having been superintendent of research at the company's mines and plants at Copper Cliff, Ont. since 1941. During the war he served the Corps of Engineers Reserves as lieutenant-colonel and participated in some of the most strenuous European campaigns. *W. K. Sproule* succeeds Mr. Queneau at Copper Cliff, having formerly been chief physicist at the research laboratory there.

Dr. *Frederick J. Winsor* has joined the engineering research department of Standard Oil Co. (Indiana) where he will have charge of welding research. Previous positions have been research assistant in the welding laboratories at Rensselaer Polytechnic Institute and research metallurgist at Armour Research Foundation.

Alexander W. Wundheiler, supervisor of ordnance research for the Navy, has been named research professor of mechanics at Illinois Institute of Technology, effective Sept. 1. A graduate of the University of Warsaw in 1932, he came to the United States in 1941 as a special lecturer at Massachusetts Institute of Technology. He has taught at other colleges, is author of two books and 25 technical papers and is a member of several technical societies.

Edward P. Barrett, widely known for re-

FELT for FILTRATION

Filter Felts are Designed for Efficient and Economical Operation in the Removal of Solid Impurities or Process Materials from Air, Gases, and Liquids

GENERAL CHARACTERISTICS

Felt is an ideal material for mechanical filtration. Retention efficiencies approximate 100 per cent; flow resistance and plugging rates are characteristically low. Because felt is highly permeable and will retain particles as small as 0.5 micron, power or pressure requirements are kept at a minimum and efficient and economical performance are assured. Designed for maximum strength and formability, filter felts may be stitched, molded or attached to frames of any desired shape to develop maximum filter area. Being a permanent type of filter material, felt may be recleaned by back-flushing, mechanical agitation or dry cleaning and is therefore extremely economical to use.

APPLICATIONS

A complete line of filter felts has been developed and standardized. See Table 1, listing these with some typical uses. These felts provide a broad range of characteristics, meeting the needs of services as diverse as air conditioning and oil filtration, industrial respirators, food products and flavors, chemicals, paint, lacquer, water, and blood (biological).

PERFORMANCE

Table 2 summarizes the performance characteristics of the standard filter felts. It will be seen that air permeabilities range from 2 to 279 CFM/sq. ft./0.5 in. water gauge. Retention efficiency of each type will vary with particle size, filter load and filtration rate, up or down from the value reported in the table for mineral dust of 0.7 micron mean diameter. For example, Mdse. 8430, rated 65% efficient in retaining such dust, will retain over 95% of pollen particles of 20 micron mean diameter. Where a retention efficiency of over 95% is wanted for particles of 0.7 micron diameter, Mdse. 1580 or 7544 should be selected. The denser felts naturally have higher retention efficiency for non-plugging fume particles or other particles of small diameter. Multi-layer filters are sometimes used to combine the advantages of a non-plugging, porous surface and a high-retention back.

TYPES

All types of filter felts are constructed for minimum plugging rate, and on comparative test for equivalent retention efficiency will demonstrate minimum initial and loaded flow resistance. Maximum air and liquid pressure limitations are indicated by the Mullen bursting strength values in pounds per square inch, Table 2. The porosity values in the same table are reported in per cent as determined by liquid volume displacement, and give the relationship of void volume to total volume.

SELECTION OF FILTER FELTS

Data given in Tables 1 and 2 can be employed in determining the correct felt for any filter application. It should be noted that Mdse. 8430 is produced in three standard weights, and if this type is selected, the weight should be specified according to the desired performance characteristics. If additional data or design suggestions are desired, you are invited to consult with an American Felt Company Product Engineer, or to communicate with the Engineering and Research Laboratories.

DATA SHEET

The material in this advertisement is condensed from "Felt and Filtration," American Felt Company Data Sheet No. 15, which also contains a helpful chart showing air flow resistance characteristics. Write on your letterhead and a copy of this Data Sheet will be sent you.

TABLE 1

Filter Felt Mdse. No.	Specification Weight-Oz./Sq. Yd.	Width	Typical Applications and Uses
X-293	7.0 - 7.3	72"	Paint Filter
1405	22.3 - 24.0	42"	Toxic dusts, fumes and mists
1580	14.0 - 15.3	54"	Industrial respirator and mask filters
3060	12.0 - 13.0	72"	Cellulose lacquer and organic solvent filtration
3074	18.0 - 19.5	72"	Nasal filters, food product and flavor filtration
3285	22.0 - 24.0	72"	Syrup and fruit juice filtration
3406	6.0 - 6.5	72"	Water faucet filter discs
5090	44.5 - 46.8	60"	Whiskey, Beer, Maple Syrup, Chrome and other plating solutions
7416	6.5 - 7.0	72"	Paint filter
7544	30.4 - 33.6	60"	Biochemical air intake filters for Intravenous Feeding Bottles
7550	16.2 - 17.4	60"	Product recovery and grain elevator filters
8430	6.5 - 7.0	72"	Air conditioning and pollen filters
8430	8.0 - 8.5	72"	Emulsion and dope filtration
8430	9.5 - 10.0	72"	Industrial air conditioning filters
8606	3.8 - 4.0	72"	Gas Mask, Activated Charcoal Filter Bag
8664	2.8 - 3.0	74"	Built up air conditioning filters
8807	3.6 - 3.9	72"	Multi-layer latex filters
70046	18.7 - 20.0	54"	Oil and fuel filters
70105	7.7 - 8.3	72"	Air compressor and compressed air filters

TABLE 2

PERFORMANCE CHARACTERISTICS

Mdse. No.	Weight (Nominal) Oz./Sq. Yd.	Mullen Bursting Strength Lbs./Sq. In.	Porosity Per Cent	Air Permeability CFM/Sq.Ft./0.5" H_2O Gauge	Retention Efficiency Per Cent*
8807	3.6- 3.9	50	93	279	45
8430	6.5- 7.0	94	86	233	65
8430	8.0- 8.5	127	86	129	76
8430	9.5-10.0	129	86	103	88
70105	7.7- 8.3	109	83	70	92
3060	12.0-13.0	225	86	50	94
70046	18.7-20.0	221	66	30	96
1580	14.0-15.3	146	79	28	98
7544	16.2-17.4	121	79	13	99
1405	22.3-24.0	235	62	2	100

*Retention of 0.7 micron mean diameter mineral dust at rated permeability.

American Felt Company
TRADE MARK

GENERAL OFFICES: GLENVILLE, CONN.
Engineering and Research Laboratories: Glenville, Conn.
PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

News of...

ENGINEERS COMPANIES SOCIETIES

search in the metallurgy of iron and steel and for 32 years in Federal service, retired July 1 as chief of the Minneapolis branch, metallurgical div., Bureau of Mines. Graduating from the Rolla, Mo. School of Mines in 1910, he taught metallurgy there and at the Oklahoma School of Mines until 1916. He is author of 38 professional publications and developed several methods for making and testing iron and steel. He has been connected with sponge iron manufacture, originated an open-hearth furnace for making steel tests and invented a simple way of making crucibles.

William D. Taylor has been made superintendent, inspection department, Lukens Steel Co. and its divisions. This department, which was previously associated with the metallurgical department, is now a separate one. Previous positions with Lukens held by Mr. Taylor were technical assistant in the metallurgical department, engineer of tests and assistant metallurgical engineer.

Fred J. Menninger has been promoted to assistant plant manager at Newark, N. J. of Federated Metals Div., American Smelting and Refining Co. The post of plant superintendent, formerly held by Mr. Menninger, will be filled by *Earl R. Marble, Jr.*, who has been serving as assistant to *John A. West*, manager, technical operations, all Federated plants.

Dr. *Henry H. Hausner*, metallurgical research laboratories, Sylvania Electric Products, Inc. and *Walter E. Kingston*, manager, those laboratories, presented papers at the First International Metal Powders Congress at Graz, Austria, at mid-July. Dr. Hausner's paper was on "Electrical Conductivity of Sintered Materials," while Mr. Kingston's was on "Mechanism of Sintering of Metal Powder Compacts." The program comprised 100 papers by authorities from a dozen countries.

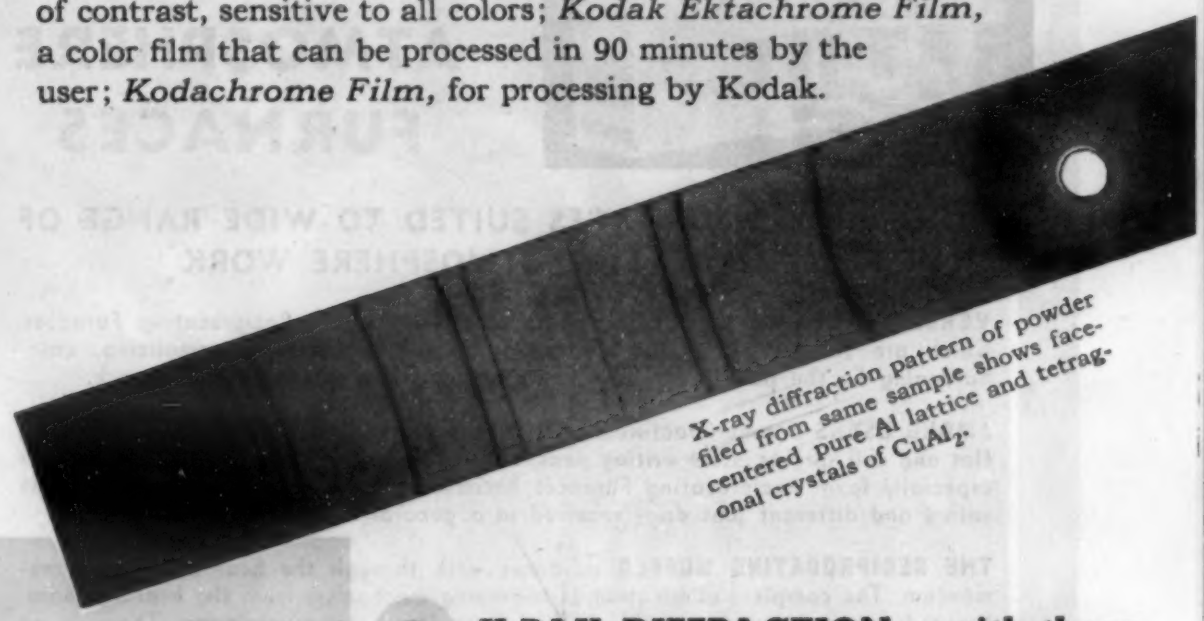
Evan Frank Wilson has been made assistant director, Division of Raw Materials, U. S. Atomic Energy Commission. He will be concerned with methods for extracting uranium from low grade domestic sources. Previously Mr. Wilson was chief metallurgist, Babcock & Wilcox Co., Barberton, Ohio. Among previous connections have been the U. S. Naval gun factory, Bureau of Mines and Frontier Bronze Corp.

Henry Wysor, metallurgical engineer, Bethlehem Steel Co., retired on July 1. He taught at Lafayette College for 14 years, the last six years serving as head of the department of metallurgy. He is succeeded by *John K. Killmer*, with Bethlehem since 1923. During the war Mr. Killmer served three years in the steel division, WPB, as chief, alloy steel branch, and as assistant director of the division.

William Brunkala has joined the techni-

Photomicrograph at 500X of aluminum alloy. Globular network is $CuAl_2$, and needle structure is alpha-AlCuFe.

1. PHOTOMICROGRAPHY . . . with these Kodak products— For recording phase distribution, and for making other detailed studies of materials directly, Kodak offers: *Kodak Metallographic Plates,* high contrast plates suited to blue or green illumination; *Kodak "M" Plates* for general photomicrography—a wide range of contrast, sensitive to all colors; *Kodak Ektachrome Film,* a color film that can be processed in 90 minutes by the user; *Kodachrome Film,* for processing by Kodak.



X-ray diffraction pattern of powder filed from same sample shows face-centered pure Al lattice and tetragonal crystals of $CuAl_2$.

3 ways photography shows STRUCTURES of materials . . .

2. X-RAY DIFFRACTION . . . with these Kodak products— For recording stresses, phases, and crystalline species by x-ray diffraction, the fastest film is *Kodak Industrial X-ray Film, Type K.* For a fine grain emulsion that permits smooth microdensitometer traces you choose Kodak Industrial X-ray Film, Type A. Three other Kodak films of different characteristics are also available for x-ray diffraction.

3. MICRORADIOGRAPHY . . . with these Kodak products— For recording composition in depth by microradiographs of the highest resolution, Kodak recommends *Kodak Spectroscopic Plates, Type 548-0,* in a holder that assures good emulsion-specimen contact. For microradiographs of lower magnification, four other Kodak materials of higher speed are available.

Microradiograph at 35X of same alloy sample. Fleecy veined structure is a projection of three-dimensional copper-rich cells, and dark crosses are copper-poor areas where solidification began during cooling of casting.

Excellent background information on Kodak Wratten Light Filters and photographic materials for use with the microscope can be found in the 174-page Kodak book "Photomicrography." Order it from your local dealer.

Also available are a chart that makes it easy to select Kodak films for x-ray diffraction, and a pamphlet that provides complete directions for building a simple holder for microradiographic specimens. For these, and answers to specific questions on products, write to Kodak.

Eastman Kodak Company, Rochester 4, N. Y.

FUNCTIONAL PHOTOGRAPHY
is advancing scientific technics

"Kodak" is a trade-mark

Kodak

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cal staff of Stearns Magnetic Mfg. Co. at Milwaukee as assistant to the physicist and research engineer in charge of the laboratory. He was graduated from the school of mining and metallurgy, University of Minnesota.

Frederick M. Bock, formerly assistant to the works manager, Burroughs Adding Machine Co., has joined Pioneer Engineering & Mfg. Co., Detroit, as assistant to the president. After the war he investigated production facilities in former enemy countries and in England and France for the U. S. War Dept.

Robert W. Frank has been made president and general manager, Lewis Foundry & Machine Div., Blaw-Knox Co. Graduated from Pennsylvania State College in metallurgical engineering in 1931 he has been in various managerial positions, such as superintendent of blooming and billet mills, Duquesne plant, Carnegie-Illinois Steel Corp.

Dr. *Clarence William Balke,* aged 68, metallurgist prominent in the development of tantalum and columbium and the atomic bomb, died at Highland Park, Ill. on July 8. In 1921 with Fansteel Corp. he was credited with producing the first ductile commercial rolled sheet of tantalum. In 1927 he developed a process for making metallic columbium, commercial production starting in 1929. He held more than 30 patents and was awarded several medals by engineering and scientific societies. As a result of his discoveries tantalum is used widely in bone and plastic surgery to provide artificial jawbones, ears and noses; to repair skull injuries and to suture skin, soft tissues, nerves, tendons and bones. It also has several industrial applications. Dr. Balke also made extensive investigation in ferrous powder metallurgy. He received his doctorate from the University of Pennsylvania and taught at Kenyon College, Ohio, University of Pennsylvania and University of Illinois.

Harry Brearley, British metallurgist to whom was accredited the discovery of stainless steel, died at Torquay, England, at the age of 77. The discovery of stainless steel was an accident, as so often happens. Mr. Brearley put more chromium than intended into alloy steel during an experiment on gun barrel erosion. He tossed the steel aside and was later astounded to find that it did not rust. In 1916 he obtained a patent on steel with 9 to 16% chromium and 0.70 carbon, particularly adaptable to cutlery. Around 1920 Britain was exporting large quantities of the stainless steel to the United States. He received the

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Bessemer medal of the British Iron & Steel Institute, its highest award. Details of the discovery of stainless steel have been sealed up and given to the Cutlers Co. of Sheffield, to be opened and read at the famous Cutler's Feast of 1960.

Roland C. Allen, aged 67, who served the United States as a metallurgical consultant in two world wars, died at Cleveland July 18. In 1946 he retired as vice president, Oglebay, Norton & Co. He was formerly president, Lake Superior Iron Ore Assn., was state geologist of Michigan and director of the Michigan Geological and Biological Survey. In the last war he was deputy chief of the iron and steel board, WPB. He belonged to several technical societies, serving as president, American Institute of Mining and Metallurgical Engineers in 1937.

Dr. *Edward Payson Mathewson* retired mining engineer and metallurgist, died at Tucson, Ariz. recently at the age of 83. For his development of copper metallurgy he won the gold medal of the Institution of Mining and Metallurgy, London, in 1911 and that of the Mining and Metallurgical Society of America in 1917. He was the inventor of improvements in blast and reverberatory furnaces for smelting copper and lead ores. In 1923 he was president of the American Institute of Mining and Metallurgical Engineers.

Companies

The *Douglas Aircraft Co., Inc.* Santa Monica, Cal. is expanding into industrial manufacturing fields not related to the aircraft industry. Thus a wide variety of pressed metal products will be made such as automobile fenders, radiator shells and other automotive parts. As general manager of the new metal products division Harry Woodhead, recently president of Consolidated-Vultee Aircraft Corp., will serve, assisted by A. W. Larsen, formerly purchasing director of Consolidated-Vultee. The new division will function as an independent unit. Mr. Woodhead has enjoyed a varied experience of 35 years with both producers and fabricators of steel.

Thirty-two European boys and girls have been touring the United States, with visits to industrial plants part of their schedule. Thus the Gary works, *Carnegie-Illinois Steel Corp.,* were their hosts recently. The tour is under the auspices of the American Field Service. Nine countries are represented

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in the group and the tour covered 5[illegible] miles.

The *Bridgeport Brass Co.* has formally acquired title from the War Assets Administration of the $17,000,000 brass plant at Indianapolis, that started production May 15, 1942 in making cartridge cases. It has been retooled and now makes a complete list of mill products—sheets, rods, tubes and other items.

The *Consolidated Steel Corp.*, Los Angeles and San Francisco, has changed its corporate name to Consolidated Western Steel Corp. The company claims to be the largest one of its kind in the West.

The *Eastman Kodak Co.* has purchased from General Mills, Inc. the latter's interest in Distillation Products, Inc., Rochester, N. Y., which pioneered in the commercial development of molecular distillation, with principal activities now the production of high-vacuum equipment, vitamins and molecular stills used in the chemical industry.

Final components of *General Electric Co.'s* welding equipment divisions were moved to Fitchburg, Mass. Aug. 1, thus making New England one of the major arc welding centers of the world.

The *Universal Atlas Cement Co.* abandoned its multiple basing point system of selling cement on July 7 following a ruling by the Supreme Court. President Blaine S. Smith, on announcing this move, said: "We believe that the sales method hitherto used by us represents the fairest, most practical and most non-discriminatory way of marketing cement. It gives customers the benefit of competition between different producers."

Olin Industries, Inc. has inaugurated decentralized products management, whereby two regional managers will have charge of all manufacturing operations at the company's East Alton, Ill. and New Haven, Conn. plants. Olin products include brass and other metals, sporting firearms and ammunition, explosives, flashlights and batteries and roller skates.

The *Hunter Pressed Steel Co.*, Lansdale, Pa., has changed its corporate name to Hunter Spring Co. to more accurately reflect the nature of its principal business, over 80% of which is making of springs. In its early history the company made grease cups, getting into spring manufacture to obtain sufficiently uniform springs for its grease cups.

Tube Turns, Inc. has acquired the Pennsylvania Forge Corp., Tacony, Philadelphia, which will continue to be operated under its present name.

The *Despatch Oven Co.*, Minneapolis, is the first equipment contractor to complete

When You Use a FORGING, You Have Done All That Can Be Done to Forestall Unpredictable Parts Failures

Macro-etch through longitudinal cross-section of pinion rack used on power shovel shows fiber-like structure in rack teeth which provides maximum resistance to wear, and strength and toughness for shocks and stresses occurring continually when in use. This fiber-like structure is common in all high quality forgings.

THERE IS NO SUBSTITUTE for the strength and toughness inherent in the forged fiber-like flow-line structure of forgings. The forging method of fabricating parts in closed impression dies directs, controls and concentrates the fiber-like flow-line structure of metals at points of greatest shock and stress. In forgings you obtain the strength and toughness for unrelenting and uninterrupted performance. When you use a forging, you have done all that can be done to forestall the failure of parts and to protect the user of your equipment from unpredictable emergencies. Forgings provide rapid assembly of complex parts as by welding; forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses. The metal quality and cost-reducing advantages obtainable in forgings cannot be equalled or duplicated. Recheck every stressed part in your equipment, and consult a forging engineer about possibilities for reducing costs of machining and finishing, speeding up assembly and improving performance. Only a forging engineer can inform you fully regarding the many advantages of forgings.

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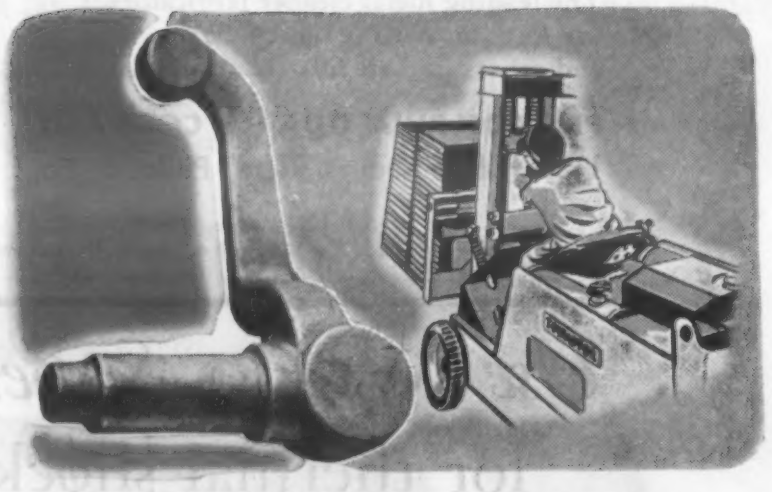
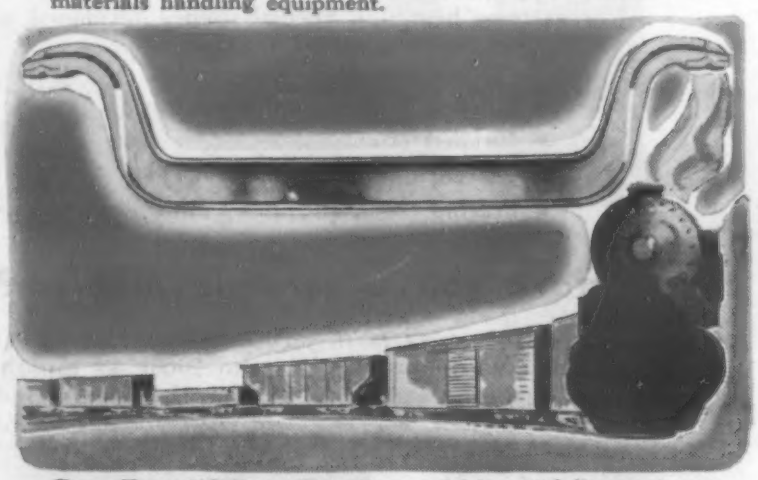


The steering mechanism of Towmotor lift trucks must operate smoothly at all times and under all kinds of loading without failure. To insure such trouble-free performance, the engineer designed this steering knuckle to be a forging, thereby obtaining a greater factor of safety which is so essential in materials handling equipment.



Drop Forged I-Beam Equalizer weighing 405 lbs. replaces an 800 lb. unit on freight cars. This illustrates how forgings reduce dead weight, yet provide a greater factor of safety that is so important in railroad operation. This drop forged I-Beam requires less machining and processing, and scrap loss is almost totally reduced because forgings are unusually free of concealed defects.

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☐ Booklet on "Metal Quality — Hot Working Improves Properties of Metal."

☐ "Drop Forging Topics" which presents numerous end use applications of forgings.

Name ..... *Position* .....

Company .....

Address ..... *City* ..... *State* .....

News of...

ENGINEERS, COMPANIES, SOCIETIES

its job of installing enameling and finish equipment for the Lustron Corp., Col bus, whose production goal of pre-fabric enameled steel houses is 45,000 homes year.

Turco Products, Inc., maker of indus cleaning compounds, has chosen McC Ill., as the site for a new modern plant augment present manufacturing facili at Chicago, Los Angeles and Houston.

The *American Cladmetals Co.*, Carne Pa., has named its first product, cop sandwiched between layers of stain steel, "Rosslyn" metal.

E. F. Houghton & Co. of Canada, L maker of industrial oils and chemic began operations in its new Toronto pl on July 15. It will specialize in manuf ture of metalworking products such as q burizers, quenching oils, heat-treating s and drawing compounds.

The *Electro Refractories & Alloys Co* Buffalo 2, has taken steps to manufac its own silicon carbide which is a pri constituent in 65% of its products. It h accordingly acquired a plant at Cap-de Madeleine, Quebec, which Canada Stea ship Lines, original owners, used for ma facture of submarines.

Stearns Magnetic Mfg. Co., Milwauke has moved into a new brick and concr plant that triples its floor space. Visit will be impressed by a solid glass fro lobby, with lighting fixtures giving reflec illumination, custom-built matching fur ture and a striking mural.

The *Bethlehem Steel Co.* has inves $100,000 in the University of Chicag program of atomic and metal researc thus becoming the thirteenth industr concern to give financial support. Indust members receive reports on all phases research three to six months before gene publication.

The *James F. Lincoln Arc Weldi Foundation* has made the following awar for providing scholarships: University Cincinnati, $1000; University of Minn sota, $500; Iowa State College, $250. Th awards were made on the basis of pape on welding by students of 46 engineerin colleges. In addition to the above, small awards of $3500 were made to 68 unde graduates of 43 engineering schools.

Societies

The *Gray Iron Founders' Society, In* has appointed Charles O. Burgess as tech nical director to initiate a long range pr gram of product improvement, technolog

News of...

ENGINEERS COMPANIES SOCIETIES

ical development, handbook preparation and technical research. For 25 years Mr. Burgess has been head of the steel and gray iron research laboratories of Union Carbide and Carbon Co. He has been granted 14 patents in the metallurgical field, seven of which deal with the improvement of cast iron. The society has recently issued a bulletin: "Gray Iron—Its Mechanical and Engineering Characteristics and Details for Designing Cast Components," by Thomas E. Eagan, Cooper-Bessemer Corp., and Charles O. Burgess.

The *American Welding Society* has made Dr. Wendell F. Hess, head of metallurgical engineering, Rensselaer Polytechnic Institute, an honorary member in view of his contributions to the society as president, second vice-president and committee chairman.

The *Franklin Institute,* Philadelphia, is also honoring Dr. Wendell F. Hess by awarding him the 1948 Wetherill medal "in consideration of his outstanding contributions to the art and science of welding, notably in the field of electric resistance welding," the presentation to be made Oct. 20. Dr. Hess is best known for his work on the color sensitiveness of photo electric cells; aluminum and its alloys welding; filters for photo electric cell as physical photo meter; magnetic properties of welded materials and for arc, gas and resistance welding.

The *American Society of Mechanical Engineers* has tendered a certificate of honorary membership to Secretary of State George C. Marshall "for his distinguished services in military science and as chief of staff and general of the army during World War II and as present Secretary of State."

The *American Electroplaters' Society* has elected as president Samuel S. Johnston, technical director, electrolytic department, Weirton Steel Co. He has previously held positions of first and second vice president. Previous experience was gained with the Carnegie Steel Co. and U. S. Bureau of Mines.

The *American Metallizing Contractors Assn.,* organized in December, 1947, held its second meeting recently at Cleveland at which seven new members joined. The new association is entirely concerned with the application of the metallizing process by commercial contract. Its members employ metallizing equipment for the contract repair of worn machine parts, the application of corrosion and heat resistant coatings and other suitable applications.

The *Industrial Furnace Manufacturers Assn., Inc.,* has appointed Ralph E. McGee, manager, metallurgical research, International Harvester Co., as one of the judges

(Continued on page 176)

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ENGINEERS COMPANIES SOCIETIES

for the IFMA prize article contest in place of the late R. H. McCarroll, Ford Motor Co. The contest provides for the awarding of $1500 in prizes for the best articles published in trade papers prior to Sept. 30, 1948 on the advantages derived from the use of modern industrial furnaces, ovens or kilns. Other judges are: George W. Mason, president, Nash-Kelvinator Corp.; Dr. S. R. Scholes, dean, New York State School of Ceramics, Alfred University; Alexander H. d'Arcambal, vice president and consulting metallurgist, Pratt & Whitney div., Niles-Bement-Pond Co.; and Dr. E. S. Davenport, assistant to vice president, United States Steel Corp.

The 1949 foundry congress of the *American Foundrymen's Society,* international technical organization of the castings industry, will be held at St. Louis, May 2-5, 1949, the purpose being to study the advances of this year in the properties and applications of castings and in production and quality control techniques and processes. An attendance of 5000 delegates from foundry centers throughout the world is expected. The general arrangements chairman is Albert L. Hunt, St. Louis plant superintendent, National Bearing Div., American Brake Shoe Co.

The *Society of the Plastics Industry, Inc.* has inaugurated an informative labeling program in cooperation with the National Retail Dry Goods Assn. and the National Consumer-Retailer Council. According to the society an ideal informative label will give six essential facts: What the product will do, what it is made of, how it is made, how to care for it, recommended uses and name of the manufacturer, distributor and sponsor.

Eleven outstanding leaders in American industry, including the presidents of eight national associations in the alloy steel consuming field and the presidents of the three largest steel producing companies, have accepted appointments from the *American Society for Metals* to serve with the society's president, Francis B. Foley, and the society's vice president, Harold K. Work, on the honorary committee covering the "Salute to Alloy Steel," central theme of the National Metal Congress and Exposition which meets in Philadelphia Oct. 25-29.

The *Meehanite Metal Corp.,* New Rochelle, N. Y. has closed two contracts for the manufacture of Meehanite castings with Pesce & Simeone, S. A., Montevideo, Uruguay and Metallurgica Wallig, S. A., Porto Alegre, Brazil.

The *Refractories Div., American Ceramic Society,* will hold its fall meeting Sept. 9 and 10 at Hotel Conneaut, Conneaut Lake Park, Pa. It will be a joint meeting with the ASTM Committee C-8 on refractories.

Meetings and Expositions

AMERICAN CHEMICAL SOCIETY, national meeting. Portland, Ore. Sept. 13-17, 1948.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. meeting. Philadelphia, Pa. Sept. 13-17, 1948.

INSTRUMENT SOCIETY OF AMERICA, annual meeting. Philadelphia, Pa. Sept. 13-17, 1948.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Aviation Div. meeting. Dayton, Ohio. Sept. 20-21, 1948.

AMERICAN MINING CONGRESS, metal mining show. San Francisco, Calif. Sept. 20-23, 1948.

ILLUMINATING ENGINEERING SOCIETY, national technical conference. Boston, Mass. Sept. 20-24, 1948.

NATIONAL ASSOCIATION OF FOREMEN, annual convention. Philadelphia, Pa. Sept. 23-25, 1948.

SOCIETY OF THE PLASTICS INDUSTRY, national plastics exposition. New York, N. Y. Sept. 27-Oct. 1, 1948.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual meeting. Cleveland, Ohio. Sept. 28-Oct. 1, 1948.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, petroleum committee of the Process Industries Div. meeting. Amarillo, Tex. Oct. 3-6, 1948.

AMERICAN GAS ASSOCIATION, annual convention. Atlantic City, N. J. Oct. 4-8, 1948.

INDUSTRIAL PACKAGING & MATERIALS HANDLING EXPOSITION. Chicago, Ill. Oct. 5-7, 1948.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic and aircraft engineering display. Los Angeles, Calif. Oct. 6-9, 1948.

AMERICAN SOCIETY OF TOOL ENGINEERS, semiannual meeting. Los Angeles, Calif. Oct. 11-13, 1948.

NATIONAL LUBRICATING GREASE INSTITUTE, annual meeting. Chicago, Ill. Oct. 11-13, 1948.

AMERICAN CHEMICAL SOCIETY, national exposition. Chicago, Ill. Oct. 12-16, 1948.

MAGNESIUM ASSOCIATION, mid-year meeting. Skytop, Pa. Oct. 13-14, 1948.

AMERICAN SOCIETY OF CHEMICAL ENGINEERS, fall meeting. Boston, Mass. Oct. 13-15, 1948.

PORCELAIN ENAMEL INSTITUTE, annual forum. Urbana, Ill. Oct. 13-15, 1948.

ELECTROCHEMICAL SOCIETY, fall meeting. New York, N. Y. Oct. 13-16, 1948.

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION, annual meeting. White Sulphur Springs, W. Va. Oct. 14-15, 1948.

BOOK REVIEWS

Metals Handbook

METALS HANDBOOK — 1948 EDITION. *Edited by Taylor Lyman. Published by American Society for Metals, Cleveland 3, Ohio, 1948. Fabrikoid, 8½ x 11 in., 1444 pages. Price $15.00.* This is a revision and substantial enlargement of the 1939 edition, and includes new theories and developments which resulted from the war effort. It is divided into four principal sections: General; Ferrous Metals; Nonferrous Metals; and Constitution of Alloys.

The General section, covering metals, processes and methods, contains new articles on mechanical testing, non-destructive inspection of metallic materials, dilatometry, wear, oxidation, stress corrosion, relief of residual stress, and service failures. Many of the other articles as well as the glossary of definitions have been revised and expanded.

In the Ferrous Metals section the treatment of cast and wrought materials used at high temperature or in corrosive environments, and the manufacture of iron and steel have been expanded; information on the iron blast furnace process has been added; a section on hardenability and a correlated set of 10 articles on the alloying elements in steel are among the innovations.

Data sheets presenting information about 220 nonferrous metals and alloys are included in the Nonferrous Metals section; discussions of melting, shaping, treating and corrosion have been enlarged. New sections are included for the eight precious metals and for 20 miscellaneous metals not discussed elsewhere.

The Constitution of Alloys section contains all articles about constitution of binary and ternary alloys, with the included phase diagrams, prepared according to a uniform style. The Index has been greatly expanded and should be even more useful than in the past.

This was a tremendous job and those responsible for it are to be congratulated on a fine piece of work. It was well worth waiting for.

Other New Books

TECHNOLOGY OF LIGHT METALS (TECHNOLOGIE DER LEICHTMETALLE). *By Alfred von Zeerleder. Published by Rascher Verlag, Zurich, Switzerland, 1947. Cloth, 6¼ x 9 in., 364 pages. Price S.Fr. 36.—(Paper bound S.Fr. 32.—). In German.* Among the topics discussed are alloys, properties and test methods, finishing and corrosion, melting, casting, rolling, press forming, drawing, wire, heat treating, spinning, welding and brazing.